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# Estimating Laboratory Needs for Municipal Wastewater Treatment Facilities

**CH2M/Hill**

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This manual provides data to make possible rough estimation of laboratory needs for municipal wastewater treatment plants. Criteria for physical facilities, staffing, and laboratory services are included. Considerations for sampling and testing needs are presented for individual processes, and include the minimum and best testing requirements. Guidelines for equipment and supplies are divided into six categories; Major equipment; misc.equipment; expendable supplies; glass and plasticware; test kits; and chemicals.

Estimates for staffing needs are given as the annual base man-hours for laboratories serving the several types of treatment facilities, and include methods for adjusting the number of man-hours for local conditions. Describes the two ways of optimizing lab. services; regional labs, and local labs serving water & wastewater facilities.

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# ESTIMATING LABORATORY NEEDS FOR MUNICIPAL WASTEWATER TREATMENT FACILITIES

OPERATION & MAINTENANCE PROGRAM
Office of Water Program Operations
U.S. Environmental Protection Agency
Washington, D.C. 20460

Contrac. No. 68-01-0328

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*U.S. Environmental Protection Agency*
*Washington, D.C. 20460*

## EPA REVIEW NOTICE

This report has been reviewed by the Water Quality Office and approved for publication.

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# CONTENTS

| Chapter | | Page |
|---|---|---|
| | SUMMARY | 1 |
| I. | INTRODUCTION | 2 |
| | Organization of Report | 2 |
| II. | SAMPLING AND TESTING PROGRAMS | 4 |
| | Philosophy of Testing | 4 |
| | Recommended Programs | 4 |
| | Additional Programs | 7 |
| III. | PHYSICAL FACILITIES | 9 |
| | Equipment, Supplies and Chemicals | 9 |
| | Requirements for Space | 11 |
| | Efficient Layout | 12 |
| IV. | STAFFING | 15 |
| | Procedure for Estimating Staffing | 15 |
| | Qualifying Factors | 16 |
| V. | LABORATORY SERVICES | 20 |
| | Regional Laboratories | 20 |
| | Combined Laboratories | 21 |
| VI. | FUTURE ENDEAVORS | 23 |

| FIGURES | | Following Page |
|---|---|---|
| Figure II-1 | Primary and Secondary Treatment Schemes | 8 |
| Figure II-2 | Physical-Chemical and Advanced Wastewater Treatment Schemes | 8 |

APPENDIXES

| | |
|---|---|
| Appendix A | Estimated Sampling and Testing Needs |
| Appendix B | Estimated Equipment and Supplies |
| Appendix C | Estimated Space Requirements |
| Appendix D | Estimated Staffing |
| Appendix E | Example Problems |
| Appendix F | Plants Surveyed |
| Appendix G | References |

# SUMMARY

Municipal wastewater treatment plant laboratories must be specifically tailored for each individual installation because of the large variety of treatment processes and the numerous combinations of processes. Because of this, the estimation of laboratory needs contained herein can be only general.

This report gives criteria for sampling and testing, physical facilities, staffing, and laboratory services.

Considerations for sampling and testing needs are for individual processes and include the minimum and the best testing requirements. The testing program of a wastewater treatment facility must be designed to meet the needs of that facility. This program can be developed from the "Estimated Unit Process Sampling and Testing Needs," found in Appendix A.

Guidelines for equipment and supplies are divided into six categories: Major Equipment, Miscellaneous Equipment, Expendable Supplies, Glass and Plasticware, Test Kits, and Chemicals. The guidelines for Major Equipment and Chemicals are based on testing requirements, while the others are usually general and indicate items needed at any laboratory.

Procedures for estimating staffing needs are essentially those given in "Estimating Staffing for Municipal Wastewater Treatment Facilities," a report prepared for the Environmental Protection Agency by CH2M/HILL, March 1973. This procedure gives the annual base man-hours for laboratories serving the several types of treatment facilities and includes methods for adjusting the number of man-hours for local conditions.

Criteria for optimizing laboratory services describe two ways in which this can be done. These are regional laboratories to serve several facilities and local laboratories that serve both water and wastewater facilities.

# I. INTRODUCTION

The suggestions for estimating laboratory needs given here should not be viewed as strict requirements. Instead, they should provide guidance in the development of a control program for a wastewater laboratory that will help assure efficient operation of the wastewater treatment facility. The criteria are suggested minimums; some laboratories can provide an efficient control program with less equipment and fewer tests. Sometimes an effective laboratory program can be operated in less space. Conversely, laboratories may have to make more intensive tests and, therefore, require more equipment. Tests may sometimes be made by uncommon, but acceptable methods. An example of this is the auto-analyzer equipment method for determining some of the various forms of nitrogen. COD tests or total organic carbon (TOC) tests, in lieu of BOD tests, should be made only when sufficient back-up data are available for BOD analysis. Local conditions and requirements will determine whether or not the laboratory can deviate from the guidelines. The control program of each laboratory must be determined by the needs of the facility it serves.

## ORGANIZATION OF REPORT

The estimated sampling and testing needs in Chapter 2 were developed for 29 of the more common unit processes. They indicate frequency of testing, the point of collecting the test sample, the method of sampling, and the reason for the test. A method is also given to determine overall testing requirements for any combination of unit processes.

Equipment guidelines in Chapter 3 were developed for major equipment, miscellaneous equipment, expendable supplies, glass and plasticware, test kits, and chemicals. These criteria for the provision of equipment and supplies were developed on the basis of minimum and optimum equipment levels and facility size.

The criteria for space requirements, also found in Chapter 3, were developed from present practices with modifications for facility type and increased testing requirements.

The procedures for estimating staffing needs in Chapter 4 are essentially those found in the report, "Estimating Staffing for Municipal Wastewater Treatment Facilities," prepared for the Environmental Protection Agency in March 1973 by CH2M/HILL [1].

Chapter 5 discusses criteria for optimizing laboratory services. Guidelines for regional laboratories, either private or government controlled, are presented. Criteria are also given for combining water and wastewater treatment plant laboratories.

The final chapter discusses suggested future endeavors for updating this report.

# II. SAMPLING AND TESTING PROGRAMS

## PHILOSOPHY OF TESTING

There are essentially four reasons for laboratory testing at wastewater treatment facilities: process control, cost control, historical data, and requirements of regulatory agencies. Process control testing includes those tests necessary to insure that a given unit process is operating properly. Cost control testing includes tests run to keep down operating expenses at the treatment facilities. Historical testing comprises those tests that provide a backlog of data of wastewater characteristics or process flow features. Although not generally used to operate the treatment facility, historical data provide a basis for design of future expansions to the treatment facilities and a record in the event of public or private investigations of facility operation. The fourth and final reason for testing, regulatory agency requirements, is determined by applicable permit requirements and local conditions such as characteristics of the receiving stream and subsequent uses of the stream.

Investigation of existing laboratory control practices at wastewater treatment facilities throughout the country preceded development of these estimating procedures. Appendix F lists plants surveyed. This investigation indicated that the laboratories of many wastewater treatment facilities conduct only those tests required by local authorities, if such requirements exist, or only those tests that suit the convenience of the treatment facility personnel. In many cases, tests were not used to operate the treatment facility or improve its efficiency. As in private industry, a wastewater treatment facility is a production process and can be operated at various levels of efficiency. The point of highest operating efficiency is that at which the highest quality of treated wastewater is produced at lowest cost. Thus, process control tests may be viewed as cost control tests, and efficient operation is assured largely by adequate laboratory control and use of laboratory data.

## RECOMMENDED PROGRAMS

The suggestions for sampling and testing differ with many present practices. The discussion above on the philosophy of testing indicates that many wastewater treatment facilities do not now diligently follow an effective laboratory control program, consequently many facilities are operated below their maximum efficiency. The development of a laboratory testing program that follows the testing suggestions and the judicious application of the resulting data should help assure more effective operation of wastewater treatment facilities.

Determination of the overall testing criteria of any particular treatment facility requires an elementary knowledge of wastewater treatment schemes. Figures II-1 and II-2 show the various combinations of treatment processes and flow schemes for primary and secondary and for physical-chemical and advanced wastewater treatment (AWT) processes. The treatment flow scheme of the particular installation should be drawn by reference to these figures before attempting to determine testing requirements.

**SAMPLING**–ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS (Appendix A) indicate the sampling points for the individual unit processes. In Appendix A the method of sampling is also indicated: either 24-hour composite or grab samples. Composite samples are combined individual samples collected at predetermined periodic intervals over a 24-hour period; the volume of each sample is proportional to the flow rate at the time of its collection. A grab sample is an individual sample, the volume of which is not proportional to the flow rate. Composite samples even out fluctuations which normally occur in the wastewater characteristics over the period of collection. Thus, the composite sample represents an average condition. Wastewater characteristics subject to change with time cannot be analyzed from the composite sample; analysis of these constituents must be made on grab samples. Examples of constituents that are subject to change with time are: pH, temperature, dissolved oxygen, and microscopic analysis of biological characteristics. Automatic samplers should be used where the guidelines indicate 24-hour composite samples.

Sample points must be located to avoid recycle flows. For example, the incoming plant flow must be sampled ahead of the point of entry of recycle flows such as digester supernatant, filter backwash, sludge thickener subnatant or supernatant, or any other in-plant recycle flows. Likewise, samples on the aeration basin influent, in the activated sludge process, must be taken ahead of the point of entry of the recycle sludge. Sampling points should be located where the flow stream is well mixed; if large particles are present, the sample should be homogenized in a laboratory blender. For a further discussion of methods of sampling and the handling of samples, refer to references [2], [3], and [4].

During design of the treatment facility, special attention should be given to location and accessibility of sampling points. Junction boxes, access manholes, or pipe taps should be provided at appropriate locations.

**TESTING**–The sampling and testing recommendations given in Appendix A were developed for individual wastewater treatment unit processes. By using this approach, the testing requirements for any combination of unit processes can be determined; however, when combining these various unit processes, some redundancy of testing will occur. This is so because certain tests suggested for the effluent from some unit processes will be identical with those suggested for the influent of immediately subsequent unit processes

This redundancy may be eliminated by the use of Work Sheets A, B, C, and D of Appendix A (pages A-30 to A-33). The use of these work sheets also allows the user to determine the overall testing needs for any given wastewater facility. Example problems are illustrated in Appendix E. The procedure for determining these testing requirements is as follows:

1. Draw a schematic flow diagram of the treatment process. Show the direction of flow between the processes by arrows. Show all recycle flows. Refer to Figures II-1 and II-2 at the end of this Chapter for assistance. Note any areas of concern, e.g., step 4, note "d" below.

2. Identify all sampling points on the schematic diagram with a symbol of the user's choice. Locate the sampling points by reference to the ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS (Appendix A).

3. Refer to the Work Sheets A, B, C, and D of Appendix A. Write in the names of the individual unit processes and flow streams on all the work sheets.

4. List all tests and their frequency on all work sheets. Refer to the ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS of Appendix A for this information.

   Notes:

   a. Plant complexity may require more than one work sheet for Work Sheets B, C, and D.

   b. For purposes of completing Work Sheet A, the initial unit process is that process immediately following any pretreatment processes as defined on Figure II-1. The final unit process is that process immediately preceding disinfection plus the disinfection process.

   c. Do not reconsider the influent to the initial unit process, or the effluent from the final unit process, in completing Work Sheet B. This was already considered in Work Sheet A.

   d. When completing Work Sheet B, for two or more process flows discharging to a common unit process, combine the effluent testing of the discharging unit processes.

e. For branching flows, sample and test ahead of the branching point. Provide flow recording in each branch, if indicated. Indicate testing only once in the work sheets. An example of this is the branching flow in the secondary clarifier underflow with the activated sludge process. Some of the flow is recycled to the aeration basin, and the waste sludge is discharged to sludge treatment. The underflow need be sampled only once at a point ahead of the branching point. These tests would be indicated on Work Sheet B for process flow from the secondary clarifier to whatever sludge treatment process is employed. Provide only flow measurement on the individual branches. In the example cited above, only flow measurement would be indicated on Work Sheet D, Recycle Flow Testing. Flow measurement for waste sludge to treatment would be indicated on Work Sheet B.

f. Consider final sludge and/or other solids disposal as a unit process for completing Work Sheet B.

5. Inspect the work sheets for testing overlaps, i.e., similar tests at successive testing points such as the effluent of a given unit process and the influent of the succeeding unit process; plant influent and initial unit process influent, final unit process effluent, and plant effluent. Select the higher testing frequency of similar tests and eliminate tests with the lower frequency.

6. In the right-hand column of each of the work sheets, list the corrected minimum and/or optional testing needs.

## ADDITIONAL PROGRAMS

In addition to the sampling and testing suggested in Appendix A, the laboratory staff often must monitor wastewater at locations other than the treatment facility, increase testing frequency, or run additional types of tests. Examples of additional tests include monitoring industrial sources, receiving water, up-line testing in the wastewater collection system, and any additional testing at the treatment facility which may be required by regulatory agencies.

Additional testing requirements must be determined on a facility by facility basis as there are too many variables to permit inclusion of all testing requirements in this report. Therefore, the user of this report should investigate thoroughly the local conditions and the regulatory agency requirements. This investigation should include consultation with personnel of the appropriate regulatory agency.

**INDUSTRIAL SOURCE MONITORING**–Monitoring for constituents from industrial sources may be necessary to determine service charges for individual industries. Constituents most commonly tested are flow, BOD, COD, suspended solids, volatile solids, pH, and temperature. Other tests may be required because of the type of industrial effluent and the processes employed at the wastewater treatment facility. The frequency of sampling and testing depends to a large degree on the characteristics of the industrial wastewater. Many industries, particularly food processing, operate only seasonally. While these industries do not require a continuous sampling and testing program, many industries operate year around and may require continual sampling and testing of their wastewater flow, particularly if wastewater characteristics fluctuate.

**RECEIVING WATER TESTING**–The amount of testing required on receiving water largely depends on the type of receiving water, e.g., lake or stream and the intended subsequent use of the receiving water. Testing requirements for receiving waters usually are determined by local regulatory authorities.

**UP-LINE TESTING**–Many municipalities may require up-line sampling and testing at strategic points throughout the wastewater collection system to pinpoint locations that contribute abnormal amounts of a given constituent.

**ADDITIONAL REGULATORY AGENCY REQUIREMENTS**–Regulatory agency requirements may dictate additional testing of wastewater characteristics to those indicated in Appendix A. These additional requirements are generally for such local conditions as climate, stream flow, other pollutional sources on the receiving stream, and subsequent uses of the receiving water. Tests may also have to be made for heavy metals, turbidity, phosphorous, and nitrogen, and may be required more often than indicated herein.

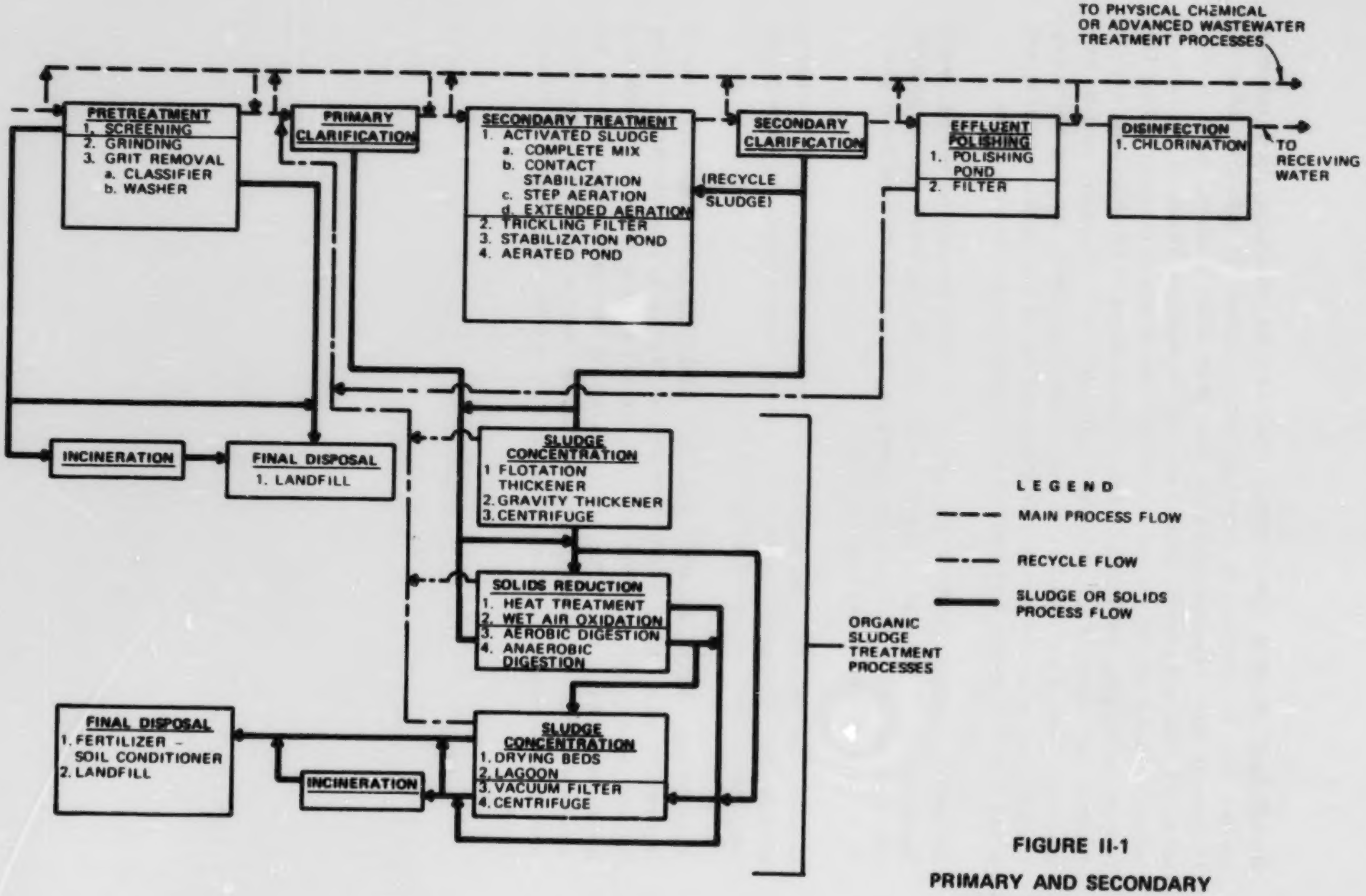
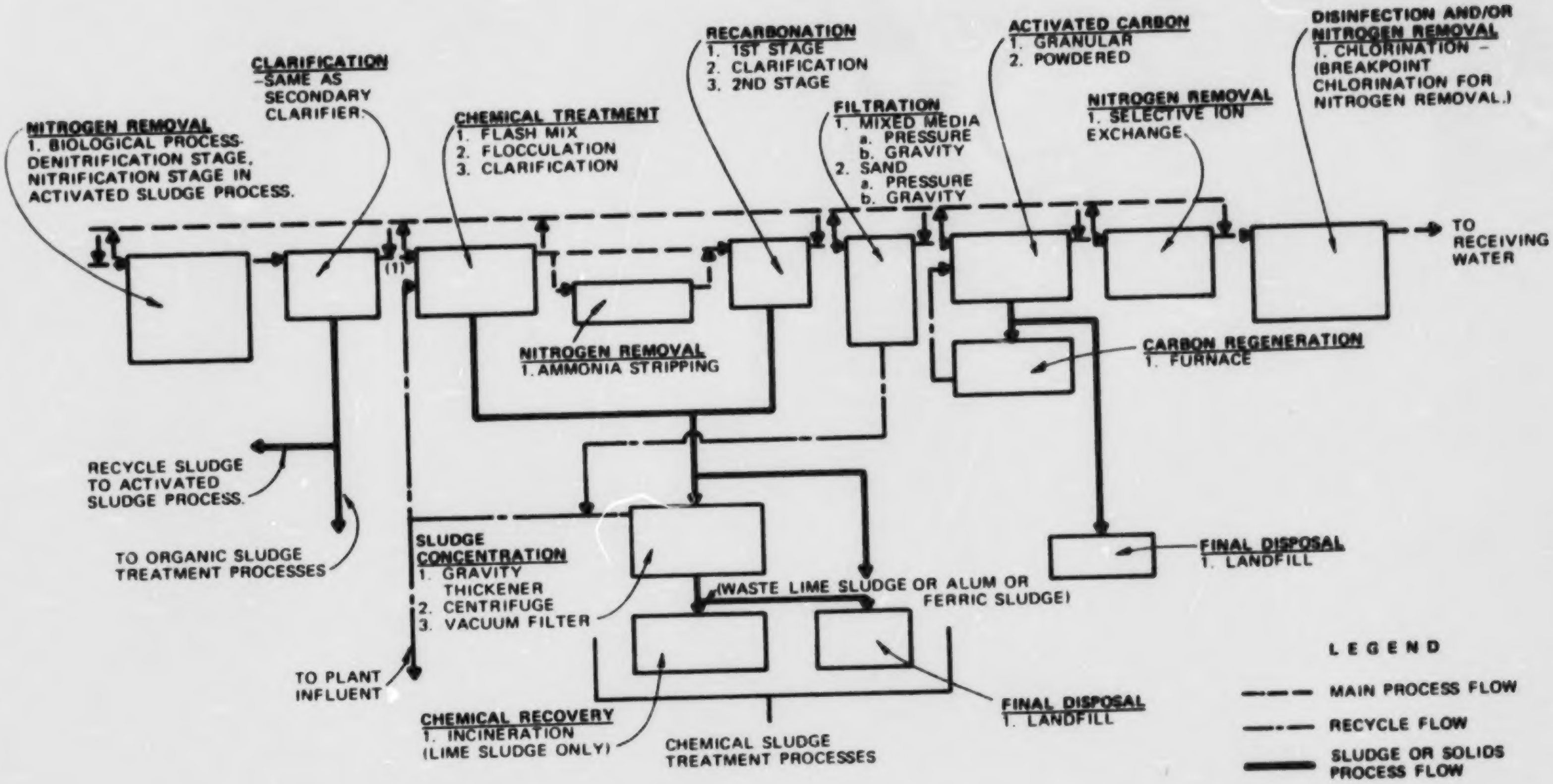

TO PHYSICAL CHEMICAL OR ADVANCED WASTEWATER TREATMENT PROCESSES
PRETREATMENT
1. SCREENING
2. GRINDING
3. GRIT REMOVAL
a. CLASSIFIER
b. WASHER
PRIMARY CLARIFICATION
SECONDARY TREATMENT
1. ACTIVATED SLUDGE
a. COMPLETE MIX
b. CONTACT STABILIZATION
c. STEP AERATION
d. EXTENDED AERATION
2. TRICKLING FILTER
3. STABILIZATION POND
4. AERATED POND
(RECYCLE SLUDGE)
SECONDARY CLARIFICATION
EFFLUENT POLISHING
1. POLISHING POND
2. FILTER
DISINFECTION
1. CHLORINATION
TO RECEIVING WATER
INCINERATION
FINAL DISPOSAL
1. LANDFILL
SLUDGE CONCENTRATION
1 FLOTATION THICKENER
2. GRAVITY THICKENER
3. CENTRIFUGE
SOLIDS REDUCTION
1. HEAT TREATMENT
2. WET AIR OXIDATION
3. AEROBIC DIGESTION
4. ANAEROBIC DIGESTION
FINAL DISPOSAL
1. FERTILIZER – SOIL CONDITIONER
2. LANDFILL
INCINERATION
SLUDGE CONCENTRATION
1. DRYING BEDS
2. LAGOON
3. VACUUM FILTER
4. CENTRIFUGE
ORGANIC SLUDGE TREATMENT PROCESSES
LEGEND
MAIN PROCESS FLOW
RECYCLE FLOW
SLUDGE OR SOLIDS PROCESS FLOW

FIGURE II-1

PRIMARY AND SECONDARY TREATMENT SCHEMES


NITROGEN REMOVAL
1. BIOLOGICAL PROCESS-DENITRIFICATION STAGE, NITRIFICATION STAGE IN ACTIVATED SLUDGE PROCESS.
CLARIFICATION
-SAME AS SECONDARY CLARIFIER.
CHEMICAL TREATMENT
1. FLASH MIX
2. FLOCCULATION
3. CLARIFICATION
RECARBONATION
1. 1ST STAGE
2. CLARIFICATION
3. 2ND STAGE
FILTRATION
1. MIXED MEDIA
a. PRESSURE
b. GRAVITY
2. SAND
a. PRESSURE
b. GRAVITY
ACTIVATED CARBON
1. GRANULAR
2. POWDERED
NITROGEN REMOVAL
1. SELECTIVE ION EXCHANGE
DISINFECTION AND/OR NITROGEN REMOVAL
1. CHLORINATION - (BREAKPOINT CHLORINATION FOR NITROGEN REMOVAL.)
TO RECEIVING WATER
(1)
NITROGEN REMOVAL
1. AMMONIA STRIPPING
CARBON REGENERATION
1. FURNACE
RECYCLE SLUDGE TO ACTIVATED SLUDGE PROCESS.
TO ORGANIC SLUDGE TREATMENT PROCESSES
SLUDGE CONCENTRATION
1. GRAVITY THICKENER
2. CENTRIFUGE
3. VACUUM FILTER
TO PLANT INFLUENT
(WASTE LIME SLUDGE OR ALUM OR FERRIC SLUDGE)
FINAL DISPOSAL
1. LANDFILL
CHEMICAL RECOVERY
1. INCINERATION (LIME SLUDGE ONLY)
CHEMICAL SLUDGE TREATMENT PROCESSES
FINAL DISPOSAL
1. LANDFILL
LEGEND
MAIN PROCESS FLOW
RECYCLE FLOW
SLUDGE OR SOLIDS PROCESS FLOW

(1) BEGIN TESTING HERE FOR "OVERALL PERFORMANCE TESTING," FOR PHYSICAL-CHEMICAL TREATMENT.

FIGURE II-2

PHYSICAL-CHEMICAL AND ADVANCED WASTEWATER TREATMENT SCHEMES

# III. PHYSICAL FACILITIES

## EQUIPMENT, SUPPLIES AND CHEMICALS

**EQUIPMENT AND SUPPLIES**–Appendix B, Tables B-1 through B-5, give estimated needs for equipment and supplies.

Minimum and optimum levels for equipment are indicated. The choice between minimum and optimum levels of equipment should be based on an evaluation of cost effectiveness and a desire to achieve optimum plant efficiency. Some typical elements to consider are the following:

- Frequency of tests.
- Sophistication of unit processes
- Trade-offs between more or better-trained lab staff vs. optimum equipment
- Trade-offs between duplicating minimum equipment items vs. replacement with fewer optimum equipment items.
- Flexibility to cope with unforeseen increases in testing requirements if optimum equipment is used.

The estimated equipment needs were developed for testing methods described in references [2] and [4]. Refer to Appendix E, "Example Problems," for illustrations or estimating equipment needs

Suggested major equipment needs, given in Table B-1, have been developed for minimum and optimum levels of equipment, plant design flow, and the type of laboratory tests. Selection of items of major equipment can be made after testing requirements have been determined.

The remaining equipment guidelines, Miscellaneous Equipment, Table B-2; Expendable Equipment, Table B-3; Glass and Plasticware, Table B-4; and Test Kits, Table B-5, have also been developed for minimum and optimum levels of equipment and plant design flow. Unlike the criteria for major equipment items, the remaining equipment needs usually are not dependent on the type of laboratory tests. These equipment items are for general laboratory use and include the various clamps, burets, beakers, graduated cylinders, dishes, glass slides, filter paper, etc., which are needed in the laboratory of any treatment facility. In some instances, pieces of glassware, equipment or supplies may be needed only for certain tests. Some examples of these are the Soxhlet Extraction Assembly, suggested in the estimated "Glass and Plasticware," Table B-4 required only for grease analysis; a reflux condenser, also suggested in the estimated "Glass and Plasticware," needed only for COD analysis; or asbestos gloves, suggested in the estimated "Expendable Supplies," Table B-3, required when the laboratory has a muffle furnace.

The estimated equipment needs indicate a range of numbers or amounts for most of the minor equipment items and supplies. The quantity of equipment and/or supplies within the indicated range should be sufficient to assure suitable operation of the laboratory. Needs of the laboratory will determine the actual number of any particular item. If the quantity of equipment is at the low end of the indicated range, personnel may be inconvenienced with frequent washing of glassware or searching for a minor equipment item. If the quantity is at the higher end of the range, some backup stock would be available to allow for breakage of equipment or depletion of supplies. This backup stock would lessen the frequency of ordering and should help prevent complete exhaustion of equipment or supply items with the consequent interruption of laboratory services. Many minor equipment and supply items may not actually be required for conducting the suggested testing program. The intent is to provide the laboratories with sufficient flexibility to change or add to their testing program as unforeseen problems arise.

Special emphasis should be given to the guidelines for expendable supplies guidelines. The quantities of items shown in this table are the average quantities that should be on hand at all times.

In some instances, outside laboratory services may be used for part or all of the testing. Suggestions for use of outside laboratories are given in Chapter V. The use of outside laboratories may permit a reduction in laboratory equipment; the amount of reduction would depend on the amount of use of such services.

**CHEMICALS**–The chemical requirements for any wastewater treatment plant laboratory may be determined from Table B-6, Chemical Needs, of Appendix B. This lists the chemicals required for each of the laboratory tests. Following each chemical, an amount is shown in parentheses. This amount, in most cases, is that which is suggested by "Standard Methods" [4] or "Methods for Chemical Analysis of Water and Wastes, 1971" [2]. The amounts will allow the preparation of sufficient quantities of reagents, such as titrants, for a reasonable number of tests. Some chemicals are used for a variety of purposes, consequently only approximate amounts could be given in Table B-6.

Common stock reagents of 15N sodium hydroxide, 10N sulfuric acid, and 6N hydrochloric acid are shown at the top of Table B-6 The quantity of chemical necessary to make up these reagents is also shown These stock reagents are of relatively high strength and are commonly used in the production of reagents of lesser strengths The stock reagents, either diluted or full strength, are used for some tests, and this is so noted for the tests listed in Table B-6 In these instances, no chemical quantity is given for the stock reagent because the quantity of chemical has already been given for the common stock reagent at the beginning of Table B-6

The amounts of the various chemicals required for a wastewater treatment laboratory are determined by first defining the overall testing needs for the given wastewater treatment facility, as illustrated in Chapter II Then determine the chemical needs from Table B-6 Twice the indicated quantities of chemicals should be ordered to provide a backup stock This backup stock will allow some flexibility in laboratory operation for minor changes in testing requirements such as periodic tests of process flow characteristics that may be required to solve plant operating problems

The chemical needs indicate only the minimum quantities of chemicals The quantities of chemicals depends largely on personal preference of laboratory personnel, economics and the degree of use of outside laboratory services. Packaging policies of chemical manufacturers will also dictate the minimum amounts of chemicals which can be purchased. Better prices can usually be obtained by purchasing chemicals in large amounts. Many chemicals, however, deteriorate with time or are subject to contamination by ordinary atmospheric constituents Such chemicals should not be purchased in large quantities

Additional testing, such as that indicated in Chapter II, will require a laboratory to carry larger stocks of chemicals than indicated in Table B-6 In most instances, a 100 percent backup stock should be sufficient to allow laboratory personnel to make any additional tests for a long enough period of time to determine future chemical needs

## REQUIREMENTS FOR SPACE

The curves for estimating space requirements are shown in Appendix C, Figures C-1 through C-3 The curves were developed from information obtained from the interviews at the various sewage treatment facilities, the comments of the plant or laboratory personnel; and the criteria for testing and for equipment and supplies contained in this publication. These curves can be read directly to find laboratory floor area, bench surface area, and cabinet volume Figures obtained from the curves include allowances for suggested increases in testing, equipment and supplies Note that the curve for estimating bench area indicates this area as a percentage of floor space; this percentage decreases with plant size. The curve for estimating cabinet volume indicates this volume directly as a function of plant size, as does the curve for estimating laboratory floor space.

The user is cautioned to note the minimum requirement for any of these areas or volumes. This minimum requirement, noted on each of the figures, is 180 square feet for floor space for activated sludge, physical-chemical and/or AWT plants; and 150 square feet for primary, trickling filter or pond-type plants. The minimum bench area is 40 percent of the floor space and the minimum cabinet volume is 200 cubic feet. The floor space suggested in Figure C-1 also includes space for laboratory office space.

The curves, developed for facilities of less than 25 mgd, were checked with laboratory floor area, bench area and cabinet volume at larger facilities and were found to agree closely with those areas and volumes.

## EFFICIENT LAYOUT

Efficient laboratory operation depends largely on the physical layout of the laboratory. The physical layout in this instance is meant to include such things as working area arrangement, the number and location of sinks and electrical outlets, the arrangement of laboratory equipment, materials of construction and lighting. The layout details can affect the accuracy of the laboratory tests. For example, tests that include identification of some colorimetric end point, such as heavy metals determinations, can be drastically affected by the type of lighting and the finishes on laboratory facilities.

An excellent discussion of criteria for laboratory layout has been developed by the Michigan Water Pollution Control Association. These criteria have been included with the 1971 edition of the Ten States Standards [5]. These criteria should be considered when laying out a laboratory.

The following list of criteria is a generalization of the items suggested in the above reference. A few minor modifications have been made.

- A northern exposure provides more uniform lighting and is preferred.

- Adequate lighting should be provided. Color corrected fluorescent lighting is suggested.

- Wall and floor finishes should be light in color and nonglare. Flat finish type wall paint is suggested. Floor finishes should be of a single color for ease of locating small items that have been dropped.

- Floor covering, in addition to being nonglare, should be easy to clean and comfortable.

- Aisle width between work benches should be at least 4 feet Also, adequate spacing should be provided around floor-standing equipment, workbenches, or file cabinets to facilitate cleaning

- Storage space for reagent stock should be under workbenches Reagent containers removed from storage areas under workbenches are less likely to be dropped than reagent containers removed from storage in the inconvenient and hard-to-reach areas above the work bench areas Only those items that are infrequently used, or chemicals of a nondangerous nature, should be stored above workbenches Strong acids or bases should never be stored out of the convenient reach of the laboratory personnel

- One sink, large enough to wash laboratory equipment, should be provided for every 25 to 30 feet of bench length One sink should be sufficient when total bench length is less than 25 feet The minimum size of this sink should be 21-1/2 inches by 15-1/2 inches by 8 inches and it should be made of chemical resistant material Cup sinks also should be provided at strategic locations on the bench surface to facilitate laboratory testing They too should be made of chemical resistant material The number of cup sinks depends largely on the type of tests that will be run The general rule, however, is one cup sink for every 25 to 30 feet of bench length These cup sinks should be alternated with the wash sinks at 12- to 15-foot intervals Where workbench assemblies are provided in the center of the laboratory, a trough type sink down the center of the workbench may be provided in lieu of cup sinks A hot and cold water tap should be placed at approximately every 5 to 10 feet along the trough.

- Electrical receptacles should be provided at strategic points for convenient and efficient operation of the laboratory. Duplex type receptacles should be spaced at 1.5-foot intervals along benches used for laboratory tests Strip molding receptacles may be used.

- Gas fixtures also should be provided at convenient locations on the bench used for laboratory tests One gas fixture should be provided for every 15-foot length of bench.

- Bench tops should be suitable for heavy duty work and resistant to chemical attack. Resin impregnated natural stone provides such a surface

- Bench surfaces should be 36 inches high and 30 inches high, respectively, for work done from standing and sitting positions.

- Bench surfaces should be at least 30 inches wide.

- Equipment arrangement should be given special consideration in laying out the laboratory facility. Pieces of equipment used for making common tests should be in close proximity. For example, the drying oven used in making total, suspended and dissolved solids tests should be close to the muffle furnace for determining total volatile solids and volatile suspended solids from the samples dried in the drying oven. The drying oven and the muffle furnace should be near the balance table because the balance is used in the weight determinations for the various solids tests.

- Safety is a prime consideration of a laboratory. The first aid kit, fire extinguisher, eye wash and emergency shower should be near the main working area of the laboratory. If the safety shower is not provided in a separate shower stall, a floor drain should be nearby.

- The analytical balance should be on a separate table. This table should be at least 30 inches in length by 24 inches deep. It should not transmit vibrations that would adversely affect the operation of the balance.

- A separate table is desirable for plants that use a microscope. This table should be about 30 inches long by 24 inches deep and 27 inches high.

- Fume hoods, if provided, should be near the area where most laboratory tests are made.

**SATELLITE LABORATORIES**–Small strategically located laboratories throughout the treatment facility may result in more efficient and convenient operation. In general, however, these satellite laboratories may be most useful in the larger wastewater treatment facilities, especially in those larger than 25 mgd and employing sophisticated methods of wastewater treatment that require close laboratory control. A large facility that uses a diversified array of biological and/or physical-chemical treatment processes could especially benefit from satellite laboratories. Small satellite laboratories may prove uneconomical for the smaller-sized wastewater treatment facilities that employ less sophisticated processes because of the extra cost of duplicated equipment and the less efficient use of this equipment and laboratory personnel.

# IV. STAFFING

Laboratory staffing guidelines are essentially those presented in "Estimating Staffing for Municipal Wastewater Treatment Facilities," prepared by CH2M/HILL for the Environmental Protection Agency in March 1973 [1]. These staffing guidelines were developed from information gathered from wastewater treatment facilities throughout the country. The information concerning laboratory staffing is summarized in Appendix D. The base level for laboratory manpower is shown in Appendix D, Figure D-1. The base level must be adjusted according to the Table of Adjustment for Local Conditions (TALC), Figure D-2.

## PROCEDURE FOR ESTIMATING STAFFING

The overall laboratory manpower estimate is determined as follows (see also Appendix E, Example Problems):

1. From Figure D-1, find the annual number of man-hours for the size and type of wastewater treatment facility under consideration.

2. From Figure D-2, select the correction percentage for the particular characteristics shown in the TALC that applies to the wastewater treatment facility under consideration.

3. Add up all the percentages for the adjustments that apply, noting which are plus and which are minus. Then multiply the man-hour figure from Figure D-1 by the total percentage (the algebraic sum of all of the percentages from the adjustments that apply) and either add or subtract the product from total number of man-hours.

4. Before converting the annual number of man-hours into number of men, the actual on-the-job hours per man per year must be estimated, a number much smaller than the theoretical 2,080 hours per year (40 hours per week by 52 weeks). The estimate, based on information obtained from operating wastewater treatment facilities, assumes:

   - o There are a maximum of 260 working days per year,

   - o Total sick leave, vacations and holidays is 29 days per year, and

   - o Produtive work amounts to 6-1/2 hours per day.

These calculations show that one person actually works 1,500 hours per year. The 1,500 figure can be adjusted for local conditions.

Subtract 10 percent from the adjusted annual laboratory manpower hours before dividing by the 1,500. Ten percent of the work is assumed to be done by personnel other than laboratory personnel regardless of plant size. This work includes such things as occasional sampling and testing by operational personnel at times when the laboratory personnel are not on duty or busy performing other lab duties.

5. The laboratory manpower figure calculated in Step 4 frequently must be adjusted by judgment. Thus, if the number of men calculated by Step 4 results in a fraction of a man, then judgment must be exercised as to whether or not to add another man. This decision will be influenced by the ability of the lesser number of laboratory personnel to get the laboratory work done, possibly with the help of the treatment facility operational staff. Such a shift in work may not be possible at union plants because of segregation of responsibilities by the union. This may require additional employees.

## QUALIFYING FACTORS

This section explains the adjustment factors included in the TALC Figure D-2. These qualifying factors can be divided into two classifications: those factors over which personnel have no control and those over which personnel associated with the facility or laboratory can exercise some control. Factors which can be attributed to the first classification are:

- Degree of treatment
- The quantity and kind of industrial waste

Those factors which fit into the second classification are:

- The extent of use of automatic samplers
- The extent of use of automatic monitoring and recording of wastewater characteristics
- The degree of use of contracted lab work
- The level of training of the laboratory personnel

This list includes only those factors which are judged to materially affect the laboratory staffing requirements. There are, of course, other factors which will affect the total annual laboratory manpower hours; however, their effect is small. One of these factors is the type of laboratory equipment used, and this factor usually will affect those laboratories with the higher budgets because those laboratories can purchase the more sophisticated laboratory testing equipment. This equipment allows tests to be made more rapidly. As an example, an analytical balance of the chain weight-type used by a low budget laboratory is slower than the more expensive analytical balance of the single pan type which may be used at a laboratory with a higher budget, and, as a consequence, the low-budget laboratory would require more manpower hours for operation than the laboratory with the single pan analytical balance. This difference of manpower hours is actually quite insignificant when compared with the total number of annual laboratory manpower hours. Other laboratory equipment may be viewed in the same way, but again the effect on the total annual laboratory manpower hour requirement is small.

The staffing estimates are most reliable for secondary wastewater treatment facilities because most of the information used in compiling them was obtained from such facilities. Thus, these estimates are not as reliable for determining laboratory staffing needs for primary and advanced wastewater facilities. The estimates will become more reliable for advanced wastewater treatment as more of these plants become operational and information regarding their needs are incorporated.

**LEVEL OF TREATMENT**–The methods of treatment used by a wastewater treatment facility dictate the testing requirements. This, in turn, affects laboratory staffing requirements. The level of treatment provided, of course, is dependent on the processes employed. A primary waste treatment facility requires the fewest tests and the smallest laboratory staff, while an AWT facility requires the largest number of tests and the largest laboratory staff.

**INDUSTRIAL WASTE**–Discharge of industrial wastes into a waste treatment facility may have an effect on laboratory staffing requirements. A plant treating a constant flow of industrial wastewater, or one treating a seasonal flow of industrial wastewater, may experience only minimum difficulty in its operation. Thus, an increase in laboratory staff to cope with the problem of industrial waste may be minimal. This assumes, of course, that the treatment facility has been designed to handle the incoming industrial wastewater. If the industrial wastewater flow is constant, then the wastewater treatment facility will be operating at its normal mode of operation when it is handling this industrial wastewater. If the industrial wastewater flow is seasonal, then seasonal changes in the mode of operation must be made. Wastewater treatment plant operators can usually anticipate seasonal changes in industrial wastewater flow and change their mode of operations accordingly. If, however, the industrial wastewater flow is erratic, a burden will be placed on the laboratory personnel as they will be required to make more frequent tests to predict the nature of the changes in the incoming wastewater flow. The effect of this erratic type industrial wastewater flow can be controlled in part by a well-enforced, strong industrial wastewater ordinance. Enforcement of such an ordinance will often require increased laboratory testing at the individual industries, and this, in turn, will increase laboratory manpower needs.

**AUTOMATIC SAMPLERS**–These guidelines assume that in addition to the testing program, laboratory personnel will also be responsible for collecting samples. The use of automatic samplers reduces laboratory staffing requirements. Automatic samplers are most commonly used on the influent and effluent of the facility. At those points where 24-hour composite samples are suggested in the testing guidelines of Chapter II, automatic samplers should be provided. The type of automatic sampler generally depends on personal preference and reliability. Any of the various pump-type sampling units are satisfactory. For unscreened raw influent, samplers using alternating vacuum and pressure to take the sample have proven very reliable. Samples collected by automatic sampling units should be delivered to the lab or some other convenient location where the individual samples are combined in a glass or plastic container and stored in a refrigerator.

**AUTOMATIC MONITORS AND RECORDERS**–The use of automatic monitoring and recording instruments will reduce the number of laboratory manpower hours in two ways. First, the use of automatic monitors will reduce the number of tests that must be run in the laboratory, and second, the automatic recording systems will lessen the time required for keeping records. The base level of laboratory staffing was developed assuming no automatic monitoring or recording systems. These base guidelines can be corrected if automatic monitors and recorders are provided, as indicated in the TALC.

The most common factors monitored and recorded by automatic means are pH, dissolved oxygen, turbidity, chlorine residual and temperature. Appendix A gives the points at the individual unit processes where automatic monitors and recorders may be used.

**OFF-PLANT LAB WORK**–At the option of the owners of the wastewater treatment facility, sampling and testing may be contracted with private or government-owned laboratories. The TALC indicates that annual laboratory manpower hours may be reduced by 10 percent in facilities that contract for testing receiving water. This table also indicates that if all laboratory work is done by contract, the laboratory staffing requirement can be reduced by 100 percent. The latter would seriously hamper day-to-day operations, however, and is not recommended. See Chapter V for a further discussion of this subject.

Monitoring of industrial wastewaters and receiving waters as indicated in TALC, up-line testing and testing for heavy metals may be done by the treatment plant laboratory, in which event the appropriate adjustments are made in staffing the laboratory of the facility. If outside laboratories provide these services, the effects of any additional testing requirements would not affect the staffing.

**LEVEL OF TRAINING**–A well-trained laboratory staff lends itself to the more efficient operation of the lab. Certification of lab personnel is one way of insuring a capable staff. Lab personnel lacking in past experience or proper training detracts from the lab operation and a larger number of lab man-hours will be required.

# V. LABORATORY SERVICES

Optimization of laboratory services may be possible in various ways. These may include the use of either private or governmental regional laboratory services or the use of common laboratory facilities or personnel for both water and wastewater treatment plants. This chapter discusses these possibilities and presents criteria for carrying out such a program.

## REGIONAL LABORATORIES

Regional laboratory services can sometimes meet laboratory needs of several wastewater treatment facilities. However, they may not always meet all of the laboratory needs of wastewater treatment facilities because information from some tests is required for process control. The time lag inherent with transporting samples, running the tests, and feedback of data would be too long for the data to be of value for this purpose. Some of the testing, however, such as overall performance tests and those tests not run for process control, may be done at regional laboratories. These regional laboratory services may be provided by either governmental or private laboratories.

Political problems could affect service of a regional governmental laboratory whereas private laboratories would not have those problems. Agreement among all subscribing governmental agencies would be required before a regional governmental laboratory could be put into operation. Another problem may arise from the variety of tests required by the subscribing treatment plants because of regulatory agency requirements and the variety of treatment processes employed at the several plants. Regional laboratory service must meet the tested requirements of all the subscribing treatment facilities. The equipment required in a regional laboratory facility can be determined from the equipment guidelines of Chapter III.

Subscribing municipalities and/or public utility districts should finance the regional laboratory service. The charge to each subscriber could be determined by the number and types of tests required. For example, each type of test may be assigned some monetary value based upon the following factors:

- o Manpower required by the test.
- o Value of chemicals used for the tests
- o Value of the equipment used

In addition to this charge, each subscriber should be charged a certain percentage of the laboratory overhead plus some percentage of the amortization of the cost of constructing the facility. The assessment to each subscriber for the general facility overhead and amortization can be a flat rate or a charge based on the testing needs of each member.

## COMBINED LABORATORIES

It may be possible, in some cases, to combine the services of laboratories provided for wastewater treatment plants and water treatment plants. Some caution must be exercised, however, in implementing such a program to prevent contamination of public water supplies. Wastewater samples should not be analyzed at the water treatment plant laboratory to prevent contamination of laboratory glassware which may next be used in sampling the water treatment process flow and thus contaminate the public water supply. Water samples could be analyzed at the wastewater treatment plant laboratory without this hazard. It will not be possible to totally eliminate a laboratory facility at the water treatment plant, however. Information obtained from some of the testing is required immediately for process control. However, the size and complexity of the laboratory may be considerably reduced.

Combining water and wastewater laboratories may prove economical by eliminating duplication of laboratory equipment and manpower. Much of the equipment used in both types of laboratories is similar. A very common example of this is the equipment required for conducting the various solids determinations. As the degree of treatment increases at the wastewater treatment facility, particularly if physical-chemical treatment processes are employed, the combining of the water and wastewater laboratories appears more favorable because the unit processes used are similar.

The laboratory work at the smaller wastewater treatment facilities is most often done by the operating personnel. They would still be required to perform their other duties whether or not the water and wastewater laboratories were combined. Thus, the combined lab may not effect a reduction in manpower requirement for the small wastewater treatment facility. Combining the water and wastewater treatment facility laboratories of smaller systems, therefore, may be unnecessary and possibly uneconomical. Generally speaking, integration of the two laboratory facilities is probably uneconomical in those systems where the estimated wastewater laboratory staff is less than one full-time laboratory person. However, on the larger systems, the possibility of combining the two laboratory facilities should be considered.

Consideration should also be given to the possibility of sharing laboratory labor between the water and wastewater laboratories. Such sharing of personnel has been successful at a number of existing installations. While this practice alleviates the problem of duplication of personnel, it will not eliminate duplication of equipment. Attempts to share laboratory personnel between water and wastewater laboratories may not prove economical for small waste treatment systems where all of the laboratory tests are conducted by the facility operators.

# VI. FUTURE ENDEAVORS

This report should be updated periodically as new laboratory methods are introduced and technology in wastewater treatment processes is advanced.

The staffing recommendations were not developed with a statistical cross section of wastewater treatment facilities, but rather from data that came largely from secondary type wastewater treatment facilities. These recommendations are, therefore, better for secondary treatment facilities than for primary and AWT facilities. Levels of staffing should be revised as more data are gathered on staffing of operating laboratories.

# APPENDIX A

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### OVERALL PERFORMANCE TESTS

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | TEMP.[1] | ALL | 1/D | I<br>E | G | H |
| | pH[1] | ALL | 1/D | I<br>E | G | H |
| | BOD[1] | ALL | 2/W | I<br>E | 24C | P |
| | DO[1] | ALL | 3/W | I<br>E | G | P |
| | SUSPENDED SOLIDS[1] | ALL | 3/W | I<br>E | 24C | P |
| | $NH_3$-N[2] | ALL | 1/W | I<br>E | 24C | P |
| | ORG-N[2] | ALL | 1/W | I<br>E | 24C | P |
| | $NO_3$-N[2] | ALL | 1/W | I<br>E | 24C | P |
| | TOTAL-P[2] | ALL | 1/W | I<br>E | 24C | P |
| | ORTHO-P[2] | ALL | 1/W | I<br>E | 24C | P |
| | TURBIDITY[2] | ALL | R | E | R | P |
| | FLOW | ALL | R | I<br>E or | R | P |
| | | | | | | |
| OPTIONAL | TOTAL SOLIDS | >1 | 2/W | I<br>E | 24C | H |
| | TOTAL VOLATILE SOLIDS | >1 | 2/W | I<br>E | 24C | H |
| | DISSOLVED SOLIDS | >1 | 2/W | I<br>E | 24C | H |
| | ALKALINITY | ALL | 2/W | I<br>E | 24C | H |
| | HEAVY METALS | >15 | 2/M | I<br>E | 24C | H |
| | COD | >5 | 2/W | I<br>E | 24C | H |
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**A. TEST FREQUENCY**

H - HOUR
D - DAY
W - WEEK
M - MONTH
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

I - INFLUENT
E - EFFLUENT

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

1. THESE TESTS SHOULD ALSO BE RUN ON RECEIVING WATER, ABOVE AND BELOW OUTFALL, ON A PERIODIC BASIS, DEPENDING ON LOCAL CONDITIONS.
2. FOR PLANTS DESIGNED TO CONTROL THIS PARAMETER.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### PRETREATMENT

**SUGGESTED MINIMUM**

| | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|
| TOTAL SOLIDS | ALL | 2/W | RG | G | P,(1)H |
| TOTAL VOLATILE SOLIDS | ALL | 2/W | RG | G | P,(1)H |
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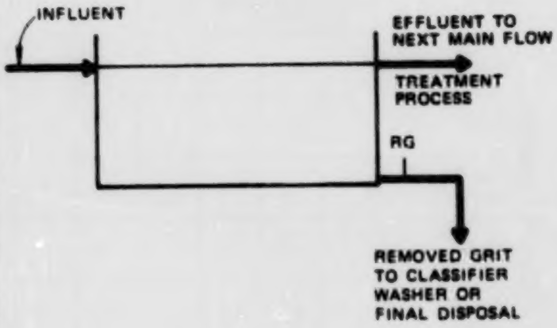
**GRIT REMOVAL**


INFLUENT
EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS
RG
REMOVED GRIT TO CLASSIFIER WASHER OR FINAL DISPOSAL

**A. TEST FREQUENCY**

H - HOUR
D - DAY
W - WEEK
M - MONTH
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

RG - REMOVED GRIT

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

1. AERATED TYPE ONLY.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### PRETREATMENT

|  |  | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | TOTAL SOLIDS | ALL | 2/W | GP | G | H |
|  | TOTAL VOLATILE SOLIDS | ALL | 2/W | GP | G | H |
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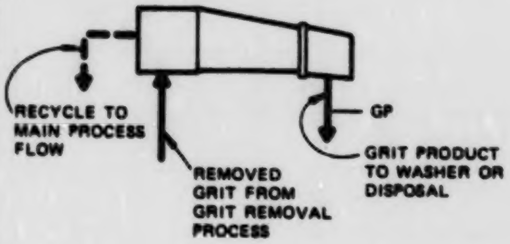
GRIT CLASSIFIER


RECYCLE TO MAIN PROCESS FLOW
REMOVED GRIT FROM GRIT REMOVAL PROCESS
GP
GRIT PRODUCT TO WASHER OR DISPOSAL

**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H | HOUR | M | MONTH |
| D | DAY | R | RECORD CONTINUOUSLY |
| W | WEEK | Mn | MONITOR CONTINUOUSLY |

**B. LOCATION OF SAMPLE**

GP - GRIT PRODUCT

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### PRETREATMENT

|  |  | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | TOTAL SOLIDS | ALL | 2/W | WG | G | H |
|  | TOTAL VOLATILE SOLIDS | ALL | 2/W | WG | G | P |
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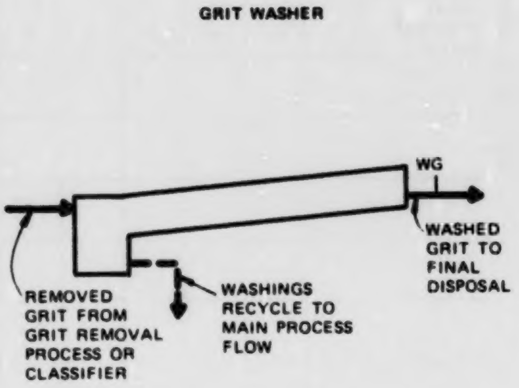
GRIT WASHER
WG
WASHED GRIT TO FINAL DISPOSAL
REMOVED GRIT FROM GRIT REMOVAL PROCESS OR CLASSIFIER
WASHINGS RECYCLE TO MAIN PROCESS FLOW

**A. TEST FREQUENCY**

H = HOUR
D = DAY
W = WEEK
M = MONTH
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

WG = WASHED GRIT

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

**E. FOOTNOTES:**

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### PRIMARY CLARIFICATION

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | BOD | ALL | 2/W | I<br>E | 24C | H |
| | SUSPENDED SOLIDS | ALL | 3/W | I<br>E | 24C | H |
| | SETTLEABLE SOLIDS | ALL | 3/W | I<br>E | G | H |
| | TOTAL SOLIDS | <1 | 3/W | S | G | P |
| | SLUDGE VOLUME LAB CENTRIFUGE | >1 | 3/D | S | G | P |
| | TOTAL SOLIDS | >1 | 1/W | S | G | P |
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| OPTIONAL | COD | >15 | 1/W | I<br>E | 24C | H |
| | VOLATILE SUSPENDED SOLIDS | >5 | 3/W | I<br>E | 24C | H |
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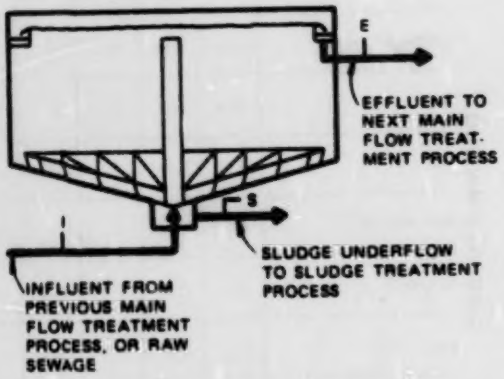
E
EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS
S
SLUDGE UNDERFLOW TO SLUDGE TREATMENT PROCESS
I
INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS, OR RAW SEWAGE

**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H | HOUR | M | MONTH |
| D | DAY | R | RECORD CONTINUOUSLY |
| W | WEEK | Mn | MONITOR CONTINUOUSLY |

**B. LOCATION OF SAMPLE**

I - INFLUENT
E - EFFLUENT
S - SLUDGE UNDERFLOW

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### SECONDARY TREATMENT

|  |  | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | BOD | ALL | 2/W | I | 24C | P |
|  | SUSPENDED SOLIDS | ALL | 5/W | E | 24C | P |
|  | SETTLEABILITY | ALL | 5/W | E | G | P |
|  | pH | ALL | 5/W | P | G | P |
|  | DO | ALL | 5/W | P | G | P |
|  | AIR INPUT(1) | ALL | R | B | R | H |
|  | $NH_3$-N(2) | ALL | 1/D | I(3) | 24C | H |
|  | ORG-N(2) | ALL | 1/D | I(3) | 24C | H |
|  | $NO_3$-N(2) | ALL | 1/D | I(3) | 24C | H |
|  | TOTAL-P(2) | ALL | 3/W | I(3) | 24C | H |
|  | ORTHO-P(2) | ALL | 3/W | I(3) | 24C | H |
|  | FLOW | ALL | R | RS | R | P |
| OPTIONAL | MICROSOPIC ANALYSIS | ALL | 2/W | P | G | H |
|  | $NO_3$-N | ALL | 3/W | P | G | P |
|  | TOTAL SOLIDS | >1 | 3/W | E | 24C | H |
|  | TOTAL VOLATILE SOLIDS | >1 | 3/W | E | 24C | H |
|  | COD | >5 | 2/W | I | 24C | H |
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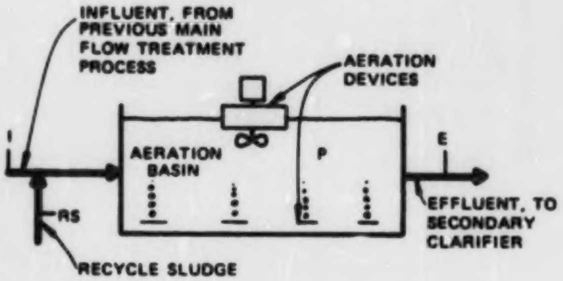
ACTIVATED SLUDGE


INFLUENT, FROM PREVIOUS MAIN FLOW TREATMENT PROCESS
AERATION DEVICES
I
AERATION BASIN
P
E
RS
EFFLUENT, TO SECONDARY CLARIFIER
RECYCLE SLUDGE

**A. TEST FREQUENCY**

H - HOUR  M - MONTH
D - DAY  R - RECORD CONTINUOUSLY
W - WEEK  Mn - MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

I - INFLUENT
E - EFFLUENT
P - PROCESS
B - BLOWER (INCLUDE WITH PROCESS TESTING)
RS - RECYCLE SLUDGE

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

1. DIFFUSED AIR ONLY.
2. TO BE RUN IF PROCESS IS DESIGNED TO CONTROL THIS PARAMETER.
3. MAYBE RUN ON PLANT INFLUENT IF THIS IS INITIAL UNIT PROCESS FOLLOWING PRETREATMENT.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### SECONDARY TREATMENT

|  |  | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | BOD | ALL | 2/W | I | 24C | P |
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| OPTIONAL | COD | >5 | 2/W | I | 24C | H |
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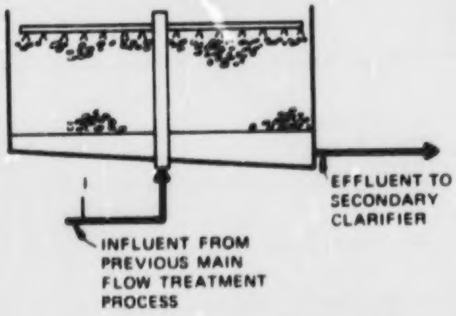
TRICKLING FILTER


I
EFFLUENT TO SECONDARY CLARIFIER
INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS

**A. TEST FREQUENCY**

H = HOUR
D = DAY
W = WEEK
M = MONTH
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

I = INFLUENT

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

**E. FOOTNOTES:**

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## SECONDARY TREATMENT

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | pH | 0 to 5 | 3/W | P | G | H |
| | DO | 0 to 5 | 1/D | P | G | H |
| | TEMP | 0 to 5 | 1/D | P | G | H |
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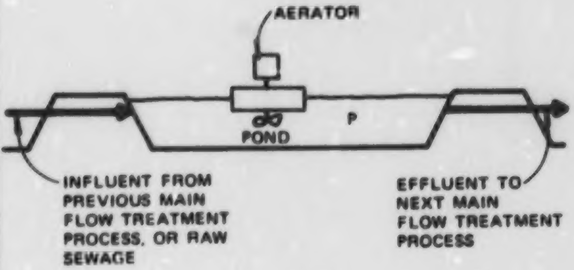
AERATED POND[1]


AERATOR
POND
P
INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS, OR RAW SEWAGE
EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS

### A. TEST FREQUENCY

| | | | |
|---|---|---|---|
| H | - HOUR | M | - MONTH |
| D | - DAY | R | - RECORD CONTINUOUSLY |
| W | - WEEK | Mn | - MONITOR CONTINUOUSLY |

### B. LOCATION OF SAMPLE

P - POND

### C. METHOD OF SAMPLE

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

### D. REASON FOR TEST

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

### E. FOOTNOTES:

1. PROCESS NOT LIKELY FOR FLOWS GREATER THAN 5 MGD.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### SECONDARY TREATMENT

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | DO | 0 to 5 | 1/W | P | G | H |
| | pH | 0 to 5 | 1/W | P | G | H |
| | TEMP | 0 to 5 | 1/W | P | G | H |
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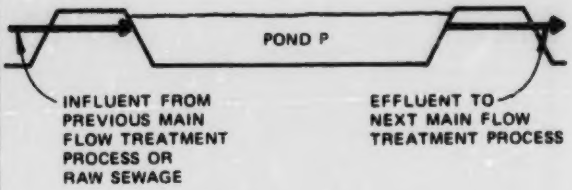
STABILIZATION PONDS[1]
(OR POLISHING POND)


POND P
INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS OR RAW SEWAGE
EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS

**A. TEST FREQUENCY**

| | |
|---|---|
| H = HOUR | M = MONTH |
| D = DAY | R = RECORD CONTINUOUSLY |
| W = WEEK | Mn = MONITOR CONTINUOUSLY |

**B. LOCATION OF SAMPLE**

P = POND

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

**E. FOOTNOTES:**

1. PROCESS NOT LIKELY FOR FLOWS GREATER THAN 5 MGD.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### SECONDARY TREATMENT

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | SUSPENDED SOLIDS | ALL | 3/W | I<br>E | 24C | P |
| | BOD | ALL | 2/W | E | 24C | H |
| | SETTLEABLE SOLIDS | ALL | 1/D | I<br>E | G | P |
| | TOTAL SOLIDS | <1 | 3/W | S | G | P |
| | $NH_3$-N[(1)] | ALL | 1/D | E | 24C | H |
| | ORG-N[(1)] | ALL | 1/W | E | 24C | H |
| | $NO_3$-N[(1)] | ALL | 1/D | E | 24C | H |
| | TOTAL-P[(1)] | ALL | 1/D | E | 24C | H |
| | ORTHO-P[(1)] | ALL | 1/D | E | 24C | H |
| | FLOW | ALL | R | WS<br>RS | R | P |
| | SLUDGE VOLUME LAB CENTRIFUGE | >1 | 3/D | S | G | P |
| | TOTAL SOLIDS | >1 | 1/W | S | G | P |
| | | | | | | |
| OPTIONAL | ALKALINITY | ALL | 1/W | 1 | 24C | P |
| | pH | ALL | 1/D | 1 | G | H |
| | TURBIDITY | >15 | Mn | E | Mn | P |
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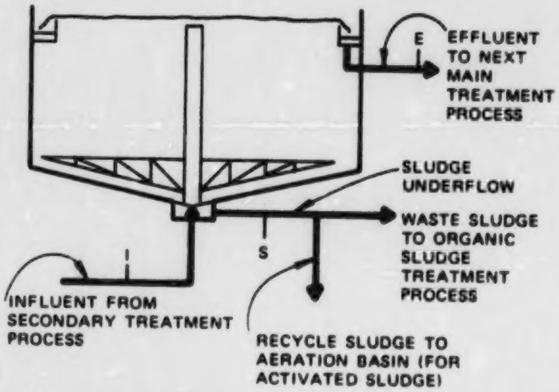
SECONDARY CLARIFIER


E
EFFLUENT TO NEXT MAIN TREATMENT PROCESS
SLUDGE UNDERFLOW
WASTE SLUDGE TO ORGANIC SLUDGE TREATMENT PROCESS
S
I
INFLUENT FROM SECONDARY TREATMENT PROCESS
RECYCLE SLUDGE TO AERATION BASIN (FOR ACTIVATED SLUDGE)

**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H | HOUR | M | MONTH |
| D | DAY | R | RECORD CONTINUOUSLY |
| W | WEEK | Mn | MONITOR CONTINUOUSLY |

**B. LOCATION OF SAMPLE**

I - INFLUENT
E - EFFLUENT
S - SLUDGE UNDERFLOW
WS - WASTE SLUDGE
RS - RECYCLE SLUDGE

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

1. TO BE RUN IF PROCESS IS DESIGNED TO CONTROL THIS PARAMETER.

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## DISINFECTION

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | CHLORINE RESIDUAL | 0 to 5 | 1/D | E | G | P<br>C |
| | CHLORINE RESIDUAL | 5 to 25 | R | E | R | P<br>C |
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| OPTIONAL | COLIFORM | ALL | 1/W | E | G | P |
| | FECAL COLIFORM | >5 | 1/W | E | G | P |
| | pH | ALL | 1/D | I | G | H |
| | TEMP | ALL | 1/D | I | G | H |
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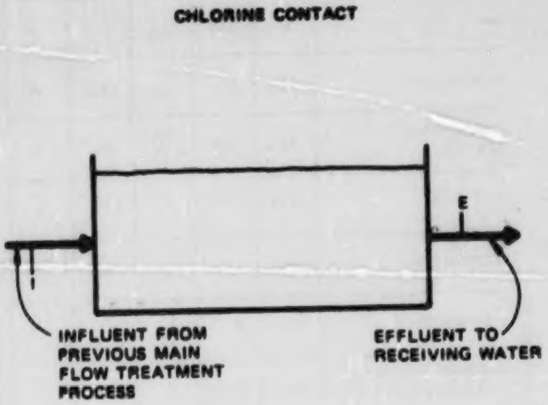

CHLORINE CONTACT
E
I
INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS
EFFLUENT TO RECEIVING WATER

**A. TEST FREQUENCY**

H - HOUR
D - DAY
W - WEEK
M - MONTH
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

I - INFLUENT
E - EFFLUENT

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

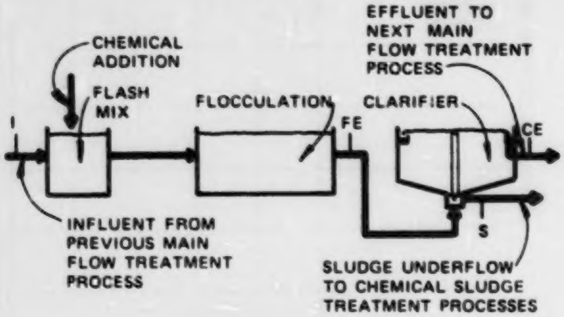
**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## CHEMICAL TREATMENT


CHEMICAL ADDITION
FLASH MIX
FLOCCULATION
FE
EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS
CLARIFIER
CE
I
S
INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS
SLUDGE UNDERFLOW TO CHEMICAL SLUDGE TREATMENT PROCESSES

NOTE: CONSIDER AS INDIVIDUAL UNIT PROCESSES.

SUGGESTED MINIMUM

| | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|
| pH | ALL | Mn | FE | Mn | P |
| pH | ALL | 1/D | I<br>CE | G | H |
| ALKALINITY | ALL | 2/W | I<br>PE | 24C | H |
| SUSPENDED SOLIDS | ALL | 1/D | FE<br>CE | 24C | H |
| JAR TEST | ALL | (1) | I | 24C | P<br>C |
| HARDNESS | ALL | 1/W | I<br>PE | 24C | H |
| TURBIDITY | ALL | R | I<br>CE | R | P |
| SLUDGE VOLUME LAB CENTRIFUGE | ALL | 3/D | S | G | P |
| TOTAL SOLIDS | >1 | 1/W | S | G | P |
| TOTAL SOLIDS | <1 | 3/W | S | G | P |
| FLOW | ALL | R | S | R | P |
| CALCIUM CONTENT(2) | ALL | (3) | LS | G | C |
| CHLORIDES(4) | ALL | 1/W | I<br>PE | 24C | H |
| SULFATES(5) | ALL | 1/W | I<br>PE | 24C | H |
| TOTAL-P(6) | ALL | 3/W | I<br>PE | 24C | H |
| ORTHO-P(6) | ALL | 3/W | I<br>PE | 24C | H |
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### A. TEST FREQUENCY

H = HOUR
D = DAY
W = WEEK
M = MONTH
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

### B. LOCATION OF SAMPLE

I = INFLUENT
FE = FLOCCULATION EFFLUENT
LS = LIME FROM SUPPLIER (INCLUDE WITH FLASH MIX PROCESS TESTING)
CE = CLARIFIER EFFLUENT
PE = PLANT EFFLUENT
S = SLUDGE UNDERFLOW

### C. METHOD OF SAMPLE

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

### D. REASON FOR TEST

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

### E. FOOTNOTES:

1. SPOT CHECK.
2. IF LIME IS USED.
3. WHEN LIME IS DELIVERED BY SUPPLIER.
4. IF FERRIC CHLORIDE IS USED.
5. IF ALUM OR FERRIC SULFATE IS USED.
6. IF PROCESS IS DESIGNED TO CONTROL THIS PARAMETER.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### NITROGEN REMOVAL

SUGGESTED MINIMUM

| | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|
| ORG-N | ALL | 1/W | I<br>E | 24C | H |
| NO$_3$-N | ALL | 1/W | I<br>E | 24C | H |
| NH$_3$-N | ALL | 1/W | I<br>E | 24C | H |
| pH | ALL | 3/D | I<br>E | G | P(1)<br>H |
| TEMP | ALL | 3/D | I<br>E | G | H |
| HARDNESS | ALL | 1/W | I<br>E | 24C | H |
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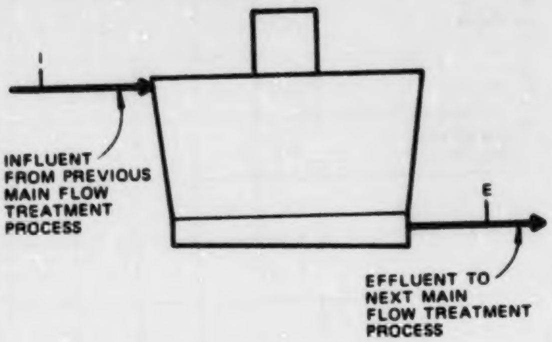
AMMONIA STRIPPING


I
INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS
E
EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS

A. TEST FREQUENCY

H - HOUR
D - DAY
W - WEEK
M - MONTH
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

B. LOCATION OF SAMPLE

I - INFLUENT
E - EFFLUENT

C. METHOD OF SAMPLE

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

D. REASON FOR TEST

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

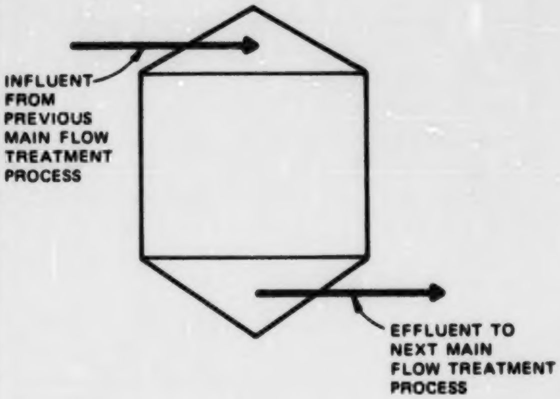
E. FOOTNOTES:

1. PROCESS CONTROL ON INFLUENT

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## NITROGEN REMOVAL

### SELECTIVE ION EXCHANGE


INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS
EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | ORG-N | ALL | 1/W | I<br>E | 24C | H |
| | $NH_3$-N | ALL | 2/D | E | G | P |
| | $NH_3$-N | ALL | 1/D | I | 24C | H |
| | $NO_3$-N | ALL | 1/W | I<br>E | 24C | H |
| | DISSOLVED SOLIDS | ALL | 3/W | I<br>E | G | H |
| | pH | ALL | 2/D | I | G | H |
| | FLOW | ALL | R | I | R | P |
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**A. TEST FREQUENCY**

H - HOUR
D - DAY
W - WEEK
M - MONTH
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## NITROGEN REMOVAL

| SUGGESTED MINIMUM | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|
| pH | ALL | Mn | PRT | Mn | P |
| pH | ALL | Mn | A.I. | Mn | P |
| $NH_3$ | ALL | (1) | A.E.<br>A.I. | G | P |
| FLOW | ALL | R | RE | R | P |
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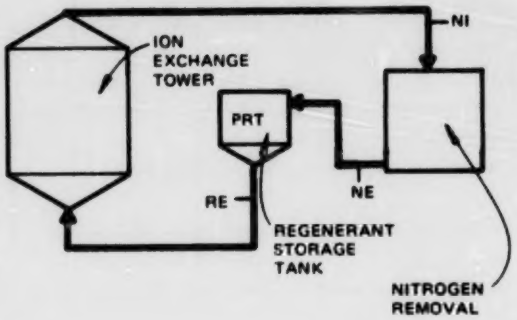
### ION EXCHANGE BED REGENERATION



**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H | HOUR | M | MONTH |
| D | DAY | R | RECORD CONTINUOUSLY |
| W | WEEK | Mn | MONITOR CONTINUOUSLY |

**B. LOCATION OF SAMPLE**

PRT = PROCESS REGENERANT TANK
AI = NITROGEN REMOVAL INFLUENT
AE = NITROGEN REMOVAL EFFLUENT
RE = REGENERANT TANK EFFLUENT

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

**E. FOOTNOTES:**

1. WHEN OPERATING REGENERATING SYSTEM.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

**NITROGEN REMOVAL**

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | ORG-N | ALL | 1/W | I<br>E | 24C | H |
| | $NH_3$-N | ALL | 1/D | I<br>E | 24C | H |
| | $NO_3$-N | ALL | 1/D | I<br>E | 24C | H |
| | CHLORINE RESIDUAL | ALL | R | E | R | P<br>C |
| | pH | ALL | Mn | I<br>E | Mn | P |
| | ALKALINITY | ALL | 2/D | I<br>E | G | P |
| | | | | | | |
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| | | | | | | |
| OPTIONAL | CHLORIDES | ALL | 2/W | I<br>E | 24C | H |
| | BOD | ALL | 2/W | I<br>E | 24C | H |
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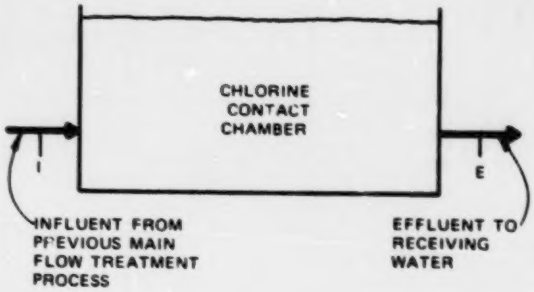
**BREAKPOINT CHLORINATION**


CHLORINE CONTACT CHAMBER
I
E
INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS
EFFLUENT TO RECEIVING WATER

**A. TEST FREQUENCY**

- H = HOUR
- D = DAY
- W = WEEK
- M = MONTH
- R = RECORD CONTINUOUSLY
- Mn = MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

- I = INFLUENT
- E = EFFLUENT

**C. METHOD OF SAMPLE**

- 24C = 24 HOUR COMPOSITE
- G = GRAB SAMPLE
- R = RECORD CONTINUOUSLY
- Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

- H = HISTORICAL KNOWLEDGE
- P = PROCESS CONTROL
- C = COST CONTROL

**E. FOOTNOTES:**

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

**NITROGEN REMOVAL**

| | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
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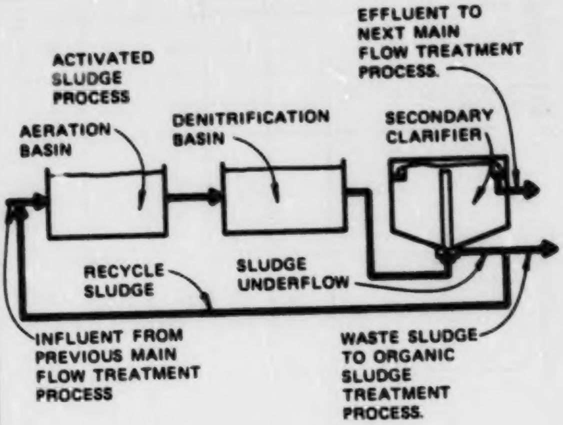
**BIOLOGICAL**[1]


EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS.
ACTIVATED SLUDGE PROCESS
AERATION BASIN
DENITRIFICATION BASIN
SECONDARY CLARIFIER
RECYCLE SLUDGE
SLUDGE UNDERFLOW
INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS
WASTE SLUDGE TO ORGANIC SLUDGE TREATMENT PROCESS.

**A. TEST FREQUENCY**

| | | | | | |
|---|---|---|---|---|---|
| H | - | HOUR | M | - | MONTH |
| D | - | DAY | R | - | RECORD CONTINUOUSLY |
| W | - | WEEK | Mn | - | MONITOR CONTINUOUSLY |

**B. LOCATION OF SAMPLE**

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

1. USE SAME TESTING SCHEDULE AS ACTIVATED SLUDGE AND SECONDARY CLARIFIER PROCESSES. INCLUDE NITROGEN TESTING INDICATED FOR ACTIVATED SLUDGE PROCESS.

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## TWO STAGE RECARBONATION

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | pH | ALL | Mn | P1S<br>P2S | Mn | P |
| | TOTAL SOLIDS LAB CENTRIFUGE | ALL | 3/D | S | G | P |
| | TOTAL SOLIDS | ALL | 1/W | P2S | 24C | H |
| | DISSOLVED SOLIDS | ALL | 1/W | P2S | 24C | H |
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| OPTIONAL | ALKALINITY | ALL | 1/D | P1S<br>P2S | 24C | H |
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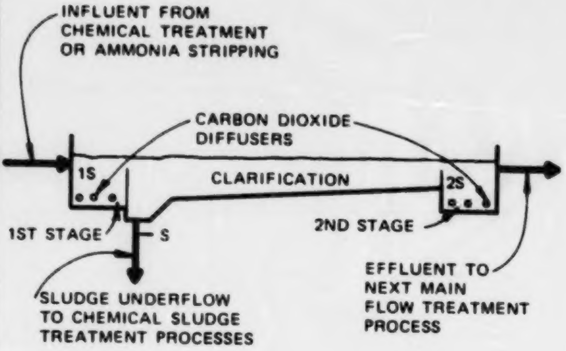
INFLUENT FROM CHEMICAL TREATMENT OR AMMONIA STRIPPING
CARBON DIOXIDE DIFFUSERS
1S
CLARIFICATION
2S
1ST STAGE
S
2ND STAGE
SLUDGE UNDERFLOW TO CHEMICAL SLUDGE TREATMENT PROCESSES
EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS

**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H = HOUR | | M = MONTH | |
| D = DAY | | R = RECORD CONTINUOUSLY | |
| W = WEEK | | Mn = MONITOR CONTINUOUSLY | |

**B. LOCATION OF SAMPLE**

P1S = PROCESS FIRST STAGE
P2S = PROCESS SECOND STAGE
S = SLUDGE UNDERFLOW

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

**E. FOOTNOTES:**

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## FILTRATION

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | TURBIDITY | ALL | R | E | R | P |
| | BOD | ALL | (1) | BW | G | P(2) |
| | SUSPENDED SOLIDS | ALL | (1) | BW | G | P |
| | FLOW | ALL | R | BW | R | P(2) |
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| OPTIONAL | BOD | ALL | 2/W | E | 24C | H |
| | SUSPENDED SOLIDS | ALL | 2/W | I<br>E | 24C | H |
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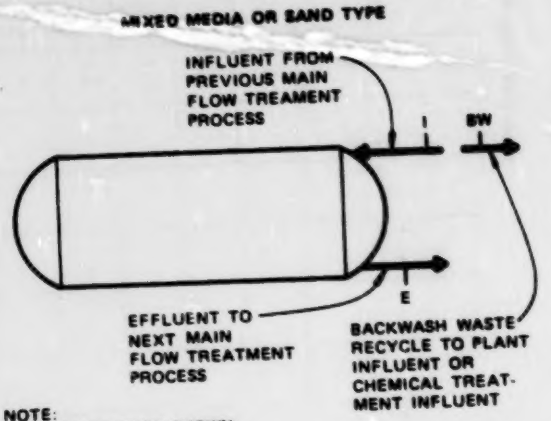
MIXED MEDIA OR SAND TYPE
INFLUENT FROM PREVIOUS MAIN FLOW TREAMENT PROCESS
I
BW
E
EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS
BACKWASH WASTE RECYCLE TO PLANT INFLUENT OR CHEMICAL TREATMENT INFLUENT

NOTE:
PRESSURE TYPE SHOWN. GRAVITY TYPE WILL HAVE SIMILAR FLOW STREAMS.

**A. TEST FREQUENCY**

H - HOUR
D - DAY
W - WEEK
M - MONTH
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

I - INFLUENT
E - EFFLUENT
BW - BACKWASH

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

1. WHEN BACKWASHING.
2. FOR CONTROL OF PROCESS RECEIVING THIS FLOW.

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## ACTIVATED CARBON ADSORPTION

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | COD | ALL | 3/W | I<br>E | 24C | H<br>P$^{(1)}$ |
| | pH | ALL | Mn | I | Mn | H<br>P$^{(2)}$ |
| | MBAS | ALL | 1/D | I<br>E | 24C | P |
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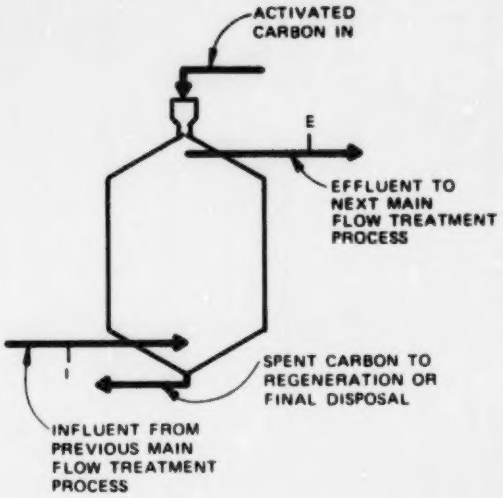
ACTIVATED CARBON IN
E
EFFLUENT TO NEXT MAIN FLOW TREATMENT PROCESS
I
SPENT CARBON TO REGENERATION OR FINAL DISPOSAL
INFLUENT FROM PREVIOUS MAIN FLOW TREATMENT PROCESS

**A. TEST FREQUENCY**

H = HOUR
D = DAY
W = WEEK
M = MONTH
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

I = INFLUENT
E = EFFLUENT

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

**E. FOOTNOTES:**

1. PROCESS CONTROL ON EFFLUENT
2. PROCESS CONTROL FOR SYSTEM EQUIPMENT FOR pH ADJUSTMENT

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

**CARBON REGENERATION**
**SLUDGE INCINERATION RECALCINATION**

| | | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|---|
| CARBON REGENERATION | SUGGESTED MINIMUM | TEMPERATURE | ALL | Mn(1) | A | Mn | P |
| | | OXYGEN CONTENT | ALL | 1/D(1) | A | G | P |
| | | PERCENT ASH | ALL | 1/D(1) | P | G | P |
| | | APPARENT DENSITY | ALL | 1/H(1) | P | G | P |
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| | OPTIONAL | IODINE NUMBER | ALL | 1/D(1) | F<br>P | G | H |
| | | APPARENT DENSITY | ALL | 1/D(1) | F | G | H |
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| SLUDGE TREATMENT | SUGGESTED MINIMUM | TEMPERATURE | ALL | Mn | A | Mn | P |
| | | TOTAL VOLATILE SOLIDS | ALL | 1/D(1) | F<br>P | G | P |
| | | TOTAL SOLIDS | ALL | 1/D(1) | F<br>P | G | P |
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| RECALCINATION | SUGGESTED MINIMUM | TEMPERATURE | ALL | Mn(1) | A | Mn | P |
| | | CALCIUM CONTENT | ALL | (2)(1) | P | G | P<br>C |
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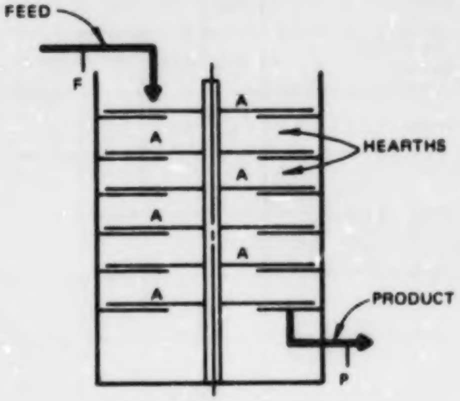
INCINERATION
(MULTIPLE HEARTH)



**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H | HOUR | M | MONTH |
| D | DAY | R | RECORD CONTINUOUSLY |
| W | WEEK | Mn | MONITOR CONTINUOUSLY |

**B. LOCATION OF SAMPLE**

| | |
|---|---|
| F | FEED |
| P | PRODUCT |
| A | FURNACE ATMOSPHERE (AT EACH HEARTH) |

**C. METHOD OF SAMPLE**

| | |
|---|---|
| 24C | 24 HOUR COMPOSITE |
| G | GRAB SAMPLE |
| R | RECORD CONTINUOUSLY |
| Mn | MONITOR CONTINUOUSLY |

**D. REASON FOR TEST**

| | |
|---|---|
| H | HISTORICAL KNOWLEDGE |
| P | PROCESS CONTROL |
| C | COST CONTROL |

**E. FOOTNOTES:**

1. WHEN FURNACE IS OPERATING
2. SPOT CHECK.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### SLUDGE CONCENTRATION

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | TOTAL SOLIDS | ALL | 1/D | TS<br>SI | G | P<br>C |
| | BOD | ALL | 2/W | SU | G | $P^{(1)}$ |
| | SUSPENDED SOLIDS | ALL | 1/D | SU | G | P |
| | FLOW | ALL | R | SU | R | $P^{(1)}$ |
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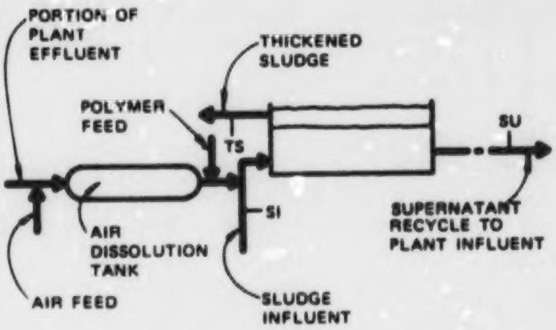
**AIR FLOTATION THICKENING**


PORTION OF PLANT EFFLUENT
THICKENED SLUDGE
POLYMER FEED
TS
SU
SI
AIR DISSOLUTION TANK
SUPERNATANT RECYCLE TO PLANT INFLUENT
AIR FEED
SLUDGE INFLUENT

**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H - HOUR | | M - MONTH | |
| D - DAY | | R - RECORD CONTINUOUSLY | |
| W - WEEK | | Mn - MONITOR CONTINUOUSLY | |

**B. LOCATION OF SAMPLE**

SI - SLUDGE INFLUENT
TS - THICKENED SLUDGE
SU - SUBNATANT

**C. METHOD OF SAMPLE**

24C - 24 HOUR COMPOSITE
G - GRAB SAMPLE
R - RECORD CONTINUOUSLY
Mn - MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H - HISTORICAL KNOWLEDGE
P - PROCESS CONTROL
C - COST CONTROL

**E. FOOTNOTES:**

1. FOR CONTROL OF PROCESS RECEIVING THIS FLOW.

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## SLUDGE CONCENTRATION

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | TOTAL SOLIDS | ALL | 1/D | TS<br>SI | G | P<br>C |
| | SUSPENDED SOLIDS | ALL | 1/D | SU | G | P |
| | BOD | ALL | 2/W | SU | G | P(1) |
| | FLOW | ALL | R | SU | R | P(1) |
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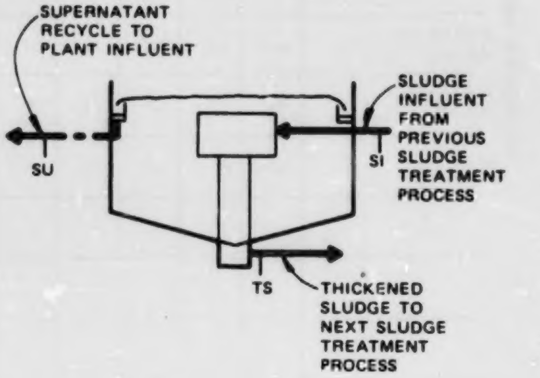
### GRAVITY THICKENER


SUPERNATANT RECYCLE TO PLANT INFLUENT
SU
SLUDGE INFLUENT FROM PREVIOUS SLUDGE TREATMENT PROCESS
SI
TS
THICKENED SLUDGE TO NEXT SLUDGE TREATMENT PROCESS

### A. TEST FREQUENCY

| | | | |
|---|---|---|---|
| H | HOUR | M | MONTH |
| D | DAY | R | RECORD CONTINUOUSLY |
| W | WEEK | Mn | MONITOR CONTINUOUSLY |

### B. LOCATION OF SAMPLE

SI = SLUDGE INFLUENT
TS = THICKENED SLUDGE
SU = SUPERNATANT

### C. METHOD OF SAMPLE

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

### D. REASON FOR TEST

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

### E. FOOTNOTES:

1. FOR CONTROL OF PROCESS RECEIVING THIS FLOW.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### SLUDGE CONCENTRATION

|  |  | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | TOTAL SOLIDS | ALL | 1/D | S<br>C | G | P |
|  | BOD | ALL | 1/W | CE | G | P(2) |
|  | SUSPENDED SOLIDS | ALL | 1/D | CE | G | P |
|  | SETTLEABLE SOLIDS | ALL | 1/H | CE | G | P |
|  | FLOW | ALL | R | CE | R | P(1) |
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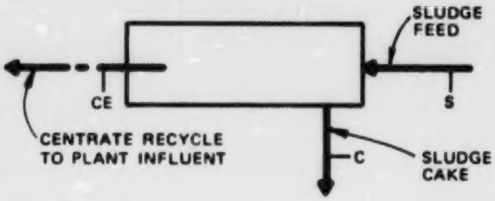
### CENTRIFUGATION(1)



NOTE:
SOLID BOWL TYPE SHOWN.
FLOW PATTERN IS SIMILAR
FOR OTHER MODELS.

**A. TEST FREQUENCY**

H = HOUR
D = DAY
W = WEEK
M = MONTH
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

S = SLUDGE FEED
C = CAKE
CE = CENTRATE

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

**E. FOOTNOTES:**

1. DAILY OPERATION ASSUMED.
2. FOR CONTROL OF PROCESS RECEIVING THIS FLOW.

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## SLUDGE CONCENTRATION

SUGGESTED MINIMUM

| | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|
| TOTAL SOLIDS | ALL | 1/D | S<br>C | G | P |
| BOD | ALL | 2/W | F | G | P(1) |
| SUSPENDED SOLIDS | ALL | 1/D | F | G | P |
| FLOW | ALL | R | F | R | P(1) |
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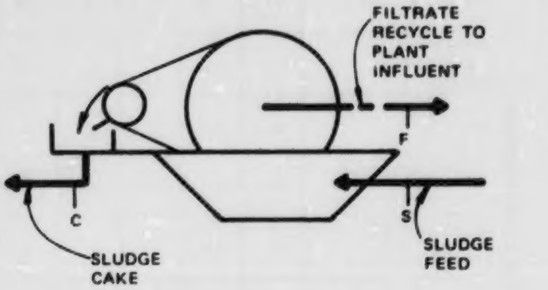
VACUUM FILTRATION



**A. TEST FREQUENCY**

H = HOUR
D = DAY
W = WEEK
M = MONTH
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**B. LOCATION OF SAMPLE**

S = SLUDGE FEED
C = SLUDGE CAKE
F = FILTRATE

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

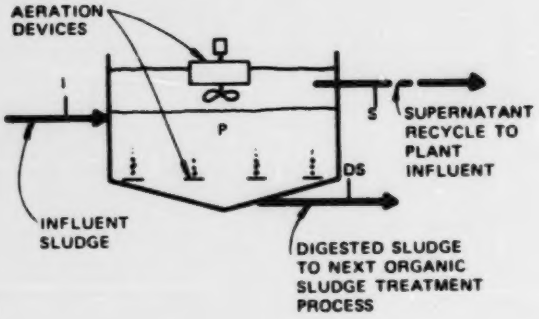
**E. FOOTNOTES:**

1. FOR CONTROL OF PROCESS RECEIVING THIS FLOW.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### SOLIDS REDUCTION

### AEROBIC DIGESTION


AERATION DEVICES
I
P
S
SUPERNATANT RECYCLE TO PLANT INFLUENT
DS
INFLUENT SLUDGE
DIGESTED SLUDGE TO NEXT ORGANIC SLUDGE TREATMENT PROCESS

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | TEMPERATURE | ALL | 1/D | P | G | H |
| | pH | ALL | 1/D | P | G | H |
| | TOTAL SOLIDS | ALL | 2/W | I<br>DS | G | H |
| | TOTAL VOLATILE SOLIDS | >1 | 2/W | I<br>DS | G | H |
| | DO | ALL | 3/W | P | G | P |
| | AIR INPUT(1) | ALL | R | B | R | P<br>C |
| | SETTLEABLE SOLIDS | ALL | 3/W | P | G | H |
| | FLOW | ALL | R | DS | R | P |
| | pH | ALL | (2) | S | G | H |
| | SUSPENDED SOLIDS | ALL | (2) | S | G | H |
| | BOD | ALL | (2) | S | G | P(3) |
| | FLOW | ALL | R | S | R | P(3) |
| | | | | | | |
| OPTIONAL | ALKALINITY | ALL | 2/W | P | G | H |
| | | | | | | |
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**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H | HOUR | M | MONTH |
| D | DAY | R | RECORD CONTINUOUSLY |
| W | WEEK | Mn | MONITOR CONTINUOUSLY |

**B. LOCATION OF SAMPLE**

I = INFLUENT
DS = DIGESTED SLUDGE
S = SUPERNATANT
P = PROCESS
B = BLOWER (INCLUDE WITH PROCESS TESTING)

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

**E. FOOTNOTES:**

1. DIFFUSED AIR ONLY.
2. WHEN DRAW OFF SUPERNATANT.
3. FOR CONTROL OF PROCESS RECEIVING THIS FLOW.

# ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

## SOLIDS REDUCTION

### ANAEROBIC DIGESTION – PRIMARY

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | TEMPERATURE | ALL | Mn | P | Mn | P |
| | pH | ALL | 1/D | P | G | P |
| | ALKALINITY | ALL | 1/D | P | G | P |
| | VOLATILE ACIDS | ALL | 3/W | P | G | P |
| | TOTAL SOLIDS | ALL | 1/W | P | G | P |
| | TOTAL VOLATILE SOLIDS | ALL | 1/W | P | G | P |
| | TOTAL VOLATILE SOLIDS | ALL | 2/W | I | G | P |
| | | | | | | |
| OPTIONAL | GAS | >5 | 1/W | G | G | P |
| | GREASE | ALL | 1/M | I<br>P | G | P |
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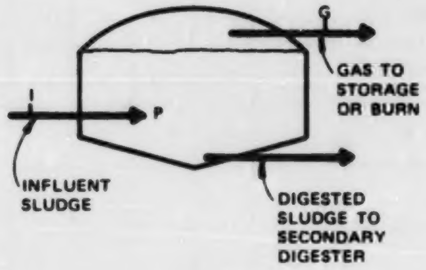

**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H | HOUR | M | MONTH |
| D | DAY | R | RECORD CONTINUOUSLY |
| W | WEEK | Mn | MONITOR CONTINUOUSLY |

**B. LOCATION OF SAMPLE**

- I - INFLUENT
- P - PROCESS
- G - GAS (INCLUDE WITH PROCESS TESTING)

**C. METHOD OF SAMPLE**

- 24C = 24 HOUR COMPOSITE
- G = GRAB SAMPLE
- R = RECORD CONTINUOUSLY
- Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

- H - HISTORICAL KNOWLEDGE
- P - PROCESS CONTROL
- C - COST CONTROL

**E. FOOTNOTES:**

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

### SOLIDS REDUCTION

| | | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|---|
| SUGGESTED MINIMUM | pH | ALL | Mn | S(1) | Mn | P |
| | TOTAL SOLIDS | ALL | (2) | U | G | H |
| | TOTAL VOLATILE SOLIDS | ALL | (2) | U | G | H |
| | BOD | ALL | 1/W | S | G | P(3) |
| | SUSPENDED SOLIDS | ALL | 1/W | S | G | H |
| | FLOW | ALL | R | S | R | P(3) |
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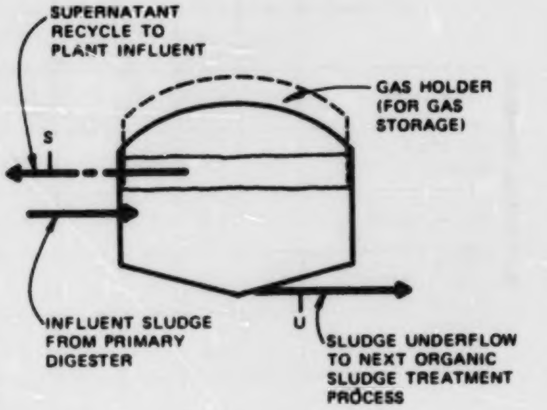
**ANAEROBIC DIGESTION – SECONDARY**


SUPERNATANT RECYCLE TO PLANT INFLUENT
GAS HOLDER (FOR GAS STORAGE)
S
INFLUENT SLUDGE FROM PRIMARY DIGESTER
U
SLUDGE UNDERFLOW TO NEXT ORGANIC SLUDGE TREATMENT PROCESS

**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H | HOUR | M | MONTH |
| D | DAY | R | RECORD CONTINUOUSLY |
| W | WEEK | Mn | MONITOR CONTINUOUSLY |

**B. LOCATION OF SAMPLE**

U = UNDERFLOW
S = SUPERNATANT

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

**E. FOOTNOTES:**

1. IN DIGESTER (INCLUDE WITH PROCESS TESTING).
2. WHEN SLUDGE IS DRAWN OFF.
3. FOR CONTROL OF PROCESS RECEIVING THIS FLOW.

## ESTIMATED UNIT PROCESS SAMPLING AND TESTING NEEDS

**SOLIDS REDUCTION**

SUGGESTED MINIMUM

|  | PLANT SIZE (MGD) | TEST FREQUENCY | LOCATION OF SAMPLE | METHOD OF SAMPLE | REASON FOR TEST |
|---|---|---|---|---|---|
| TOTAL SOLIDS | ALL | 1/D | I<br>DU | G | P |
| TEMPERATURE | ALL | Mn | R | Mn | P |
| pH | ALL | 1/D | D | G | H |
| SUSPENDED SOLIDS | ALL | 1/D | D | G | H |
| BOD | ALL | 2/W | D | G | P(1) |
| FLOW | ALL | R | D | R | P(1) |
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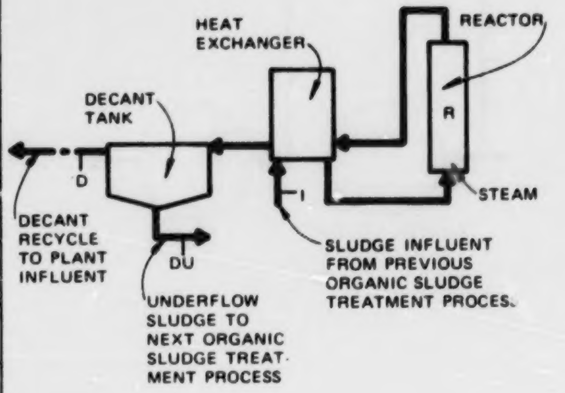
**WET AIR OXIDATION AND HEAT TREATMENT**


HEAT EXCHANGER
REACTOR
R
DECANT TANK
D
I
STEAM
DECANT RECYCLE TO PLANT INFLUENT
DU
SLUDGE INFLUENT FROM PREVIOUS ORGANIC SLUDGE TREATMENT PROCES.
UNDERFLOW SLUDGE TO NEXT ORGANIC SLUDGE TREAT- MENT PROCESS

**A. TEST FREQUENCY**

| | | | |
|---|---|---|---|
| H = HOUR | | M = MONTH | |
| D = DAY | | R = RECORD CONTINUOUSLY | |
| W = WEEK | | Mn = MONITOR CONTINUOUSLY | |

**B. LOCATION OF SAMPLE**

I = INFLUENT
D = DECANT
R = REACTOR (INCLUDE AS PROCESS TESTING)
DU= DECANT UNDERFLOW

**C. METHOD OF SAMPLE**

24C = 24 HOUR COMPOSITE
G = GRAB SAMPLE
R = RECORD CONTINUOUSLY
Mn = MONITOR CONTINUOUSLY

**D. REASON FOR TEST**

H = HISTORICAL KNOWLEDGE
P = PROCESS CONTROL
C = COST CONTROL

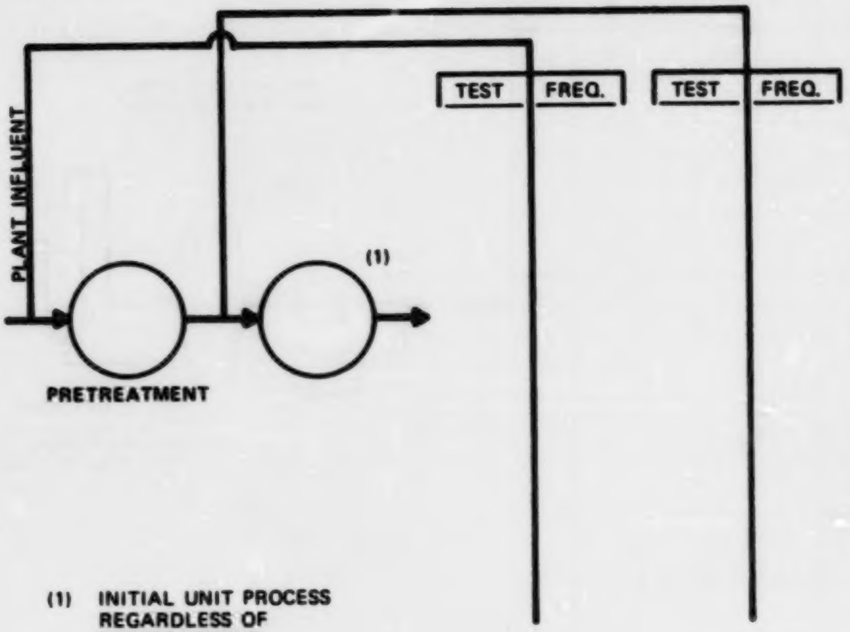
**E. FOOTNOTES:**

1. FOR CONTROL OF PROCESS RECEIVING THIS FLOW.

## WORKSHEET A

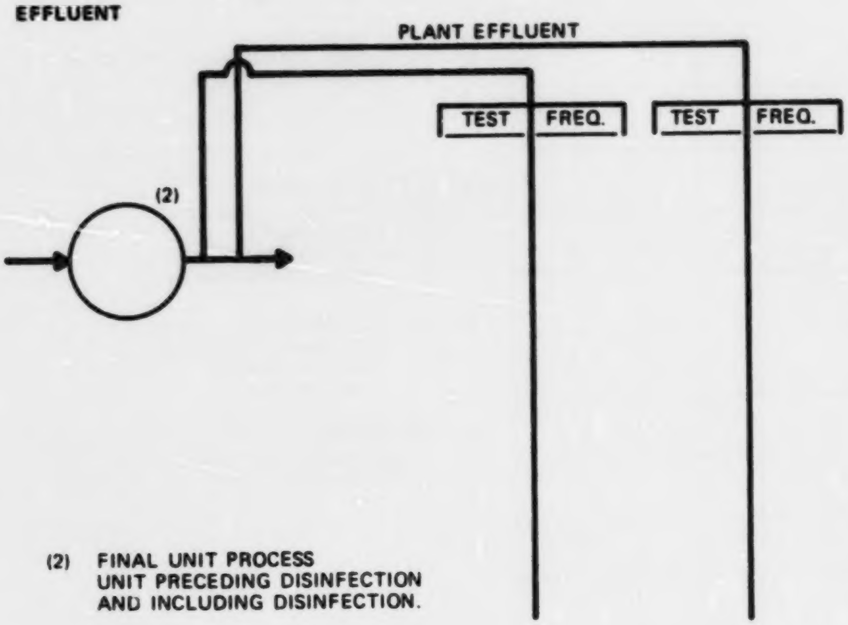
## OVERALL PERFORMANCE TESTING

**INFLUENT**


PLANT INFLUENT
(1)
PRETREATMENT
TEST
FREQ.
TEST
FREQ.

(1) INITIAL UNIT PROCESS REGARDLESS OF PRETREATMENT

**EFFLUENT**

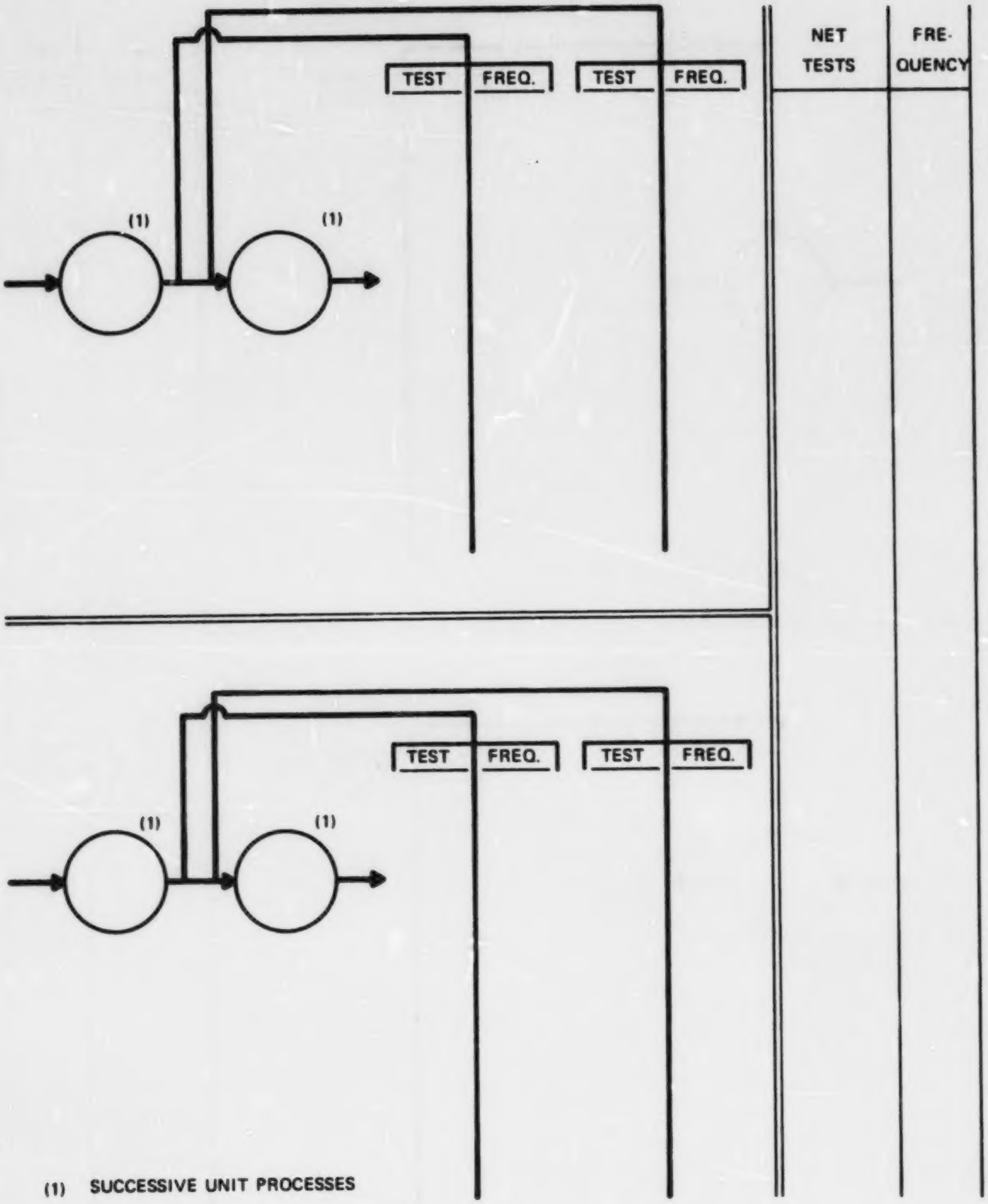

PLANT EFFLUENT
(2)
TEST
FREQ.
TEST
FREQ.

(2) FINAL UNIT PROCESS UNIT PRECEDING DISINFECTION AND INCLUDING DISINFECTION.

| NET TESTS | FRE-QUENCY |
|---|---|
| | |

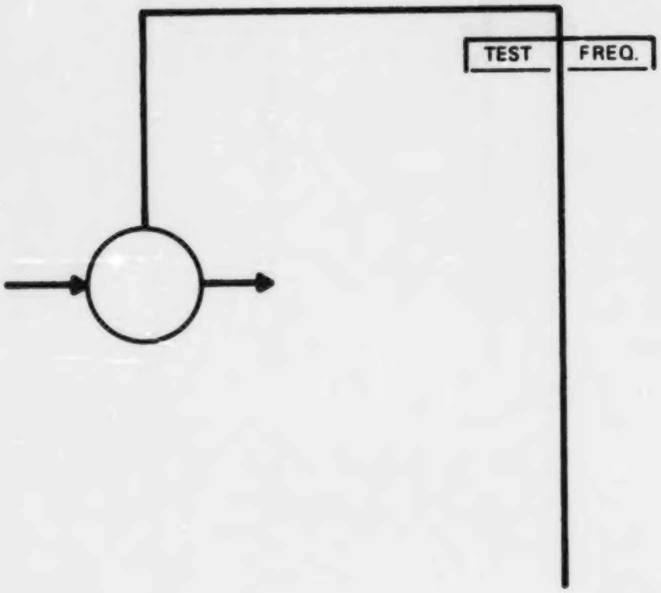
## WORKSHEET B

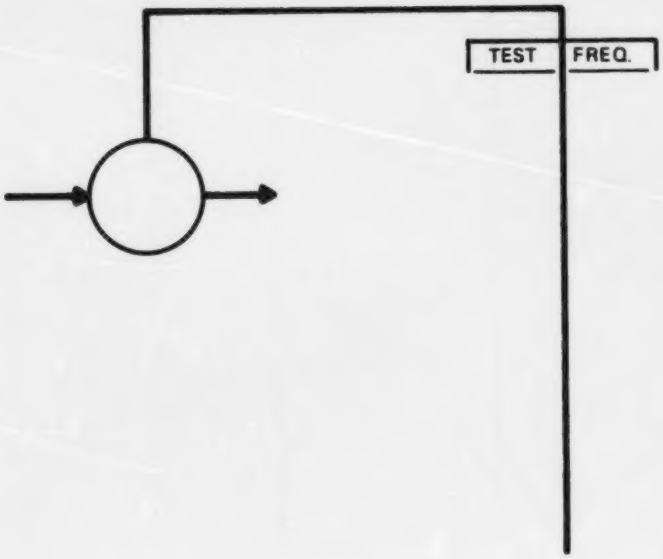
## PROCESS FLOW TESTING


TEST
FREQ.
TEST
FREQ.
NET TESTS
FRE-QUENCY
(1)
(1)
TEST
FREQ.
TEST
FREQ.
(1)
(1)

(1) SUCCESSIVE UNIT PROCESSES

## WORKSHEET C
## PROCESS TESTING

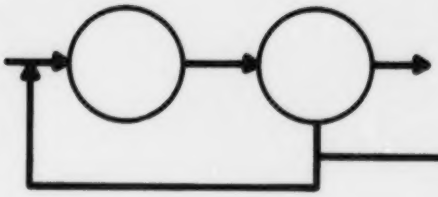




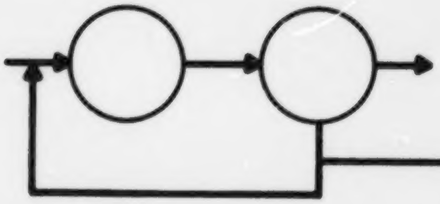
| NET TESTS | FREQUENCY |
|---|---|

# WORKSHEET D

## RECYCLE FLOW TESTING



| TEST | FREQ. |
|---|---|
| | |



| TEST | FREQ. |
|---|---|
| | |

| NET TEST | FRE-QUENCY |
|---|---|
| | |

# APPENDIX B

## ESTIMATED EQUIPMENT AND SUPPLIES

Major Equipment Page B-1
Miscellaneous Equipment Page B-20
Expendable Supplies Page B-22
Glass and Plasticware Page B-24
Test Kits Page B-29
Chemicals Page B-30

## TABLE B-1

## MAJOR EQUIPMENT GUIDELINES

**AUTOTRANSFORMER** -- For: COD, Grease.

Minimum

Not required.

Optimum

All plant sizes; variable, 2.6 KVA

**BALANCE** -- For: General Lab Use.

Minimum

0 to 1 mgd; analytical balance, double pan, chain weighing weight set, class S-1.

1 to 5 mgd; same as 0 to 1 mgd; plus triple beam balance.

5 to 15 mgd; analytical, single pan, substitution weighing, digital indicating with optical tare; plus triple beam balance.

15 to 25 mgd; analytical, single pan, substitution weighing, digital indicating with optical tare; plus double beam balance, dial weighing, magnetic damper.

Optimum

0 to 1 mgd; analytical balance, single pan, substitution weighing, digital indicating, with optical tare; plus top loading balance, direct reading, single pan, digital indicating 1,200 gm; plus moisture determination balance.

1 to 5 mgd; analytical balance, single pan, substitution weighing, digital indicating, optical tare, coarse weighing device and zero base readout; plus top loading balance, direct reading, single pan, digital indicating, 1200 gm; plus moisture determination balance.

5 to 15 mgd; same as 1 to 5 mgd.

15 to 25 mgd, same as 1 to 5 mgd.

BLENDER -- For: General Lab Use.

Minimum

All plant sizes; reducing and emulsifying, two-speed, 1 liter capacity.

BOOK CASE -- For: General Lab Use (May be built-in type).

Minimum

0 to 1, and 1 to 5 mgd; 2 shelf, 30" length, 12" deep.

5 to 15, and 15 to 25 mgd; 4 shelf, 30" length, 12" deep.

CENTRIFUGE -- For: Volatile Acids; Sludge Volume - Lab Centrifuge; General Lab Use - Optimum level larger than 5 mgd.

Minimum

0 to 1 mgd; clinical centrifuge, 6 place, 15 ml; plus polycarbonate tubes, graduated, 15 ml.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd.

15 to 25 mgd; same as 0 to 1 mgd; plus clinical centrifuge, 4 place, 50 ml; plus borosilicate tubes, conical, graduated, 50 ml; plus adapter for supporting tubes in centrifuge head, reducing, 15 to 50 ml.

Optimum

0 to 1 mgd; clinical centrifuge, 6 place, 15 ml; plus polycarbonate tubes, graduated, 15 ml.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd; plus International Model HN-S centrifuge or equivalent; head, 6 place 50 ml.; metal shields, 15 ml; metal shields, 50 ml.; trunnion carrier, 3 place, 15 ml.; trunnion ring, 50 ml.; polycarbonate tubes 15 ml; borosilicate tubes, conical, graduated, 50 ml.

15 to 25 mgd; same as 5 to 15 mgd.

CHLORINE RESIDUAL ANALYZER AND RECORDER -- For: Chlorine residual continuous recording.

Minimum

All plant sizes; analyzer, plus recorder.

DESK CHAIR -- For: General Lab Use.

Minimum

0 to 1 mgd; None required

1 to 5 mgd; None required

5 to 15 mgd; Swivel, arm chair.

15 to 25 mgd; Swivel, arm chair.

EYE WASH -- For: General Lab Use.

Minimum

0 to 1 mgd; irrigator, 32 oz.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; face wash, hand held spray type.

15 to 25 mgd; same as 5 to 15 mgd.

Optimum

All plant sizes; included with safety shower.

FILE CABINET -- For: General Lab Use.

Minimum

0 to 1, 1 to 5, and 5 to 15 mgd; 2-drawer metal.

15 to 25 mgd; 4-drawer metal.

**FLOC STIRRER** -- For: Jar Tests.

Minimum

All plant sizes; 6 unit device, electric.

Optimum

All plant sizes; 6 unit device, illuminated, electric.

**FLOW METER** -- For: Flow Measurement, Continuous Recording.

Minimum

All plant sizes; Type dependent on plant design. Totalizer Indicator required for all plant types.

Optimum

All plant sizes; Type dependent on plant design. Continuous recorder required for all plant types. Continuous remote recorder, indicator, and totalizer required for all plant types.

**FUME HOOD** -- For: Volatile Acids, $NH_3$-N, Org-N (When sum of frequency for above tests is 2 per day or more); Heavy Metals.

Minimum

All plant sizes; open type with gas and cold water fixtures, cup sink, and electrical receptacle.

**GAS ANALYZER** -- For: Digester Gas Analysis, Oxygen in Furnace Atmosphere.

Minimum

0 to 1 mgd, and 1 to 5 mgd; not required.

5 to 15 mgd; Flue gas, valveless automatic bubbling pipettes.

15 to 25 mgd; same as 5 to 15 mgd.

**HEATING MANTLES** -- For: COD, Grease.

**Minimum**

Not required.

**Optimum**

0 to 1 mgd; not required.

1 to 5 mgd; 250 ml. electric.

5 to 15 mgd; 250 ml. electric; plus 500 ml. electric.

15 to 25 mgd; same as 5 to 15 mgd.

**HOOD (TISSUE CULTURE)** -- For: Coliform, Fecal Coliform.

**Minimum**

Not required.

**Optimum**

0 to 1 mgd, 1 to 5 mgd; not required.

15 to 25 mgd; reinforced plastic, fluorescent lamp, and germicidal lamp.

**HOT PLATE** -- For: General Lab Use.

**Minimum**

0 to 1 mgd; electric, 12 inch x 13 inch, thermostatic control.

1 to 5 mgd; Same as 0 to 1 mgd.

5 to 15 mgd; Same as 0 to 1 mgd.

15 to 25 mgd; Same as 0 to 1 mgd.

Optimum

0 to 1 mgd; electric, 12 inch x 13 inch thermostatic control.

1 to 5 mgd; electric, circular plate, 6-1/2 inch diameter, thermostatic control.

5 to 15 mgd; Same as 1 to 5 mgd.

15 to 25 mgd; Same as 1 to 5 mgd.

INCUBATOR (BOD) -- For: BOD

Minimum

All plant sizes; low temperature, 5° - 50°C, mechanical cooling and capacity of 200 standard BOD bottles.

INCUBATOR (MICROBIOLOGICAL) -- For: Coliforms.

Minimum

0 to 1 mgd; 5 tube capacity, thermostatic control.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; microbiological, electric, thermostatic control, 35 membrane filter plastic petri dish capacity.

15 to 25 mgd; same as 5 to 15 mgd.

Optimum

All plant sizes; electric, thermostatic control, stainless steel interior, inside dimensions, 13 inch x 14 inch x 13 inch.

**KJELDAHL DIGESTING AND DISTILLING APPARATUS** -- For: Total Kjeldahl Nitrogen (Ammonia plus Organic Nitrogen)

Minimum

0 to 1 mgd; digesting and distilling unit, 2 place electric, 500 watt heaters.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; distilling unit, 2 place electric, 550 watt heaters, for 500 or 800 ml. flasks; plus digesting unit, 2 place electric, 550 watt heaters, for 500 or 800 ml. flasks.

15 to 25 mgd; same as 5 to 15 mgd.

Optimum

0 to 1 mgd; digesting and distilling unit, 2 place electric, 500 watt heaters.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; distilling unit, 2 place electric, 550 watt heaters, for 500 or 800 ml. flasks (S63430); plus digesting unit, 2 place electric, 550 watt heaters, for 500 or 800 ml. flasks.

15 to 25 mgd; same as 5 to 15 mgd.

**LAB STOOL** -- For: General Lab Use.

Minimum

All plant sizes; (minimum 1 plus 1 extra for each lab personnel); 13 inch diameter steel seat, adjustable height between 18 inches and 26 inches.

MAGNETIC STIRRER -- For: General Lab Use.

Minimum

0 to 1 mgd, 1 to 5 mgd, and 5 to 15 mgd; not required.

15 to 25 mgd; variable speed, illuminating.

Optimum

0 to 1 mgd, 1 to 5 mgd, and 5 to 15 mgd; variable speed, illuminating magnetic stirrer.

15 to 25 mgd; same as above; plus variable speed non-illuminating magnetic stirrer.

MICROSCOPE -- For: Microscopic Analysis.

Minimum

0 to 1 mgd; 10X ocular, 4X, 10X, 43X objectives.

1 to 5 mgd; Same as 0 to 1 mgd.

5 to 15 mgd; Same as 0 to 1 mgd.

15 to 25 mgd; Same as 0 to 1 mgd.

Optimum

0 to 1 mgd; 10X ocular, 4X, 10X, 45X, 100X objectives.

1 to 5 mgd; Same as 0 to 1 mgd.

5 to 15 mgd; Same as 0 to 1 mgd.

15 to 25 mgd; Same as 0 to 1 mgd.

MUFFLE FURNACE -- For: Total Volatile Solids, Volatile Suspended Solids, Percent Ash.

Minimum

0 to 1 mgd; Maximum temperature 1900°F, muffle dimensions 4-7/8 inches x 4-1/4 inches x 6 inches.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd.

15 to 25 mgd; same as 0 to 1 mgd.

Optimum

0 to 1 mgd; maximum temperature 1900°F, muffle dimensions 4-7/8 inches x 4-1/4 inches x 6 inches.

1 to 5 mgd; maximum temperature 2000°F, proportioning controller, muffle dimensions 3-5/8 inches x 5-1/2 inches x 6-1/2 inches.

5 to 15 mgd; maximum temperature 2000°F, no controller, muffle size 9-1/2 inches x 8-1/2 inches x 13-1/2 inches; plus controller millivoltmeter type electronic pyrometer, range 2000°F.

15 to 25 mgd; same as 5 to 15 mgd.

OFFICE DESK -- For: General Lab Use.

Minimum

0 to 1 mgd; none required.

1 to 5 mgd; none required.

5 to 15 mgd; single pedestal.

15 to 25 mgd; same as 5 to 15 mgd.

Optimum

0 to 1 mgd; none required.

1 to 5 mgd; none required.

5 to 15 mgd; double pedestal.

15 to 25 mgd; same as 5 to 15 mgd.

OVEN -- For: Suspended Solids, Total Solids, Dissolved Solids, Grease.

Minimum

0 to 1 mgd; gravity convection, single wall, electric, 200°C thermostatic control, inside dimensions 11-1/2 inches x 11-1/4 inches x 9 inches.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd.

15 to 25 mgd; same as 0 to 1 mgd.

Optimum

0 to 1 mgd; mechanical convection, with base, electric, 325°C, inside dimensions 25 inches x 19 inches x 19 inches.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd.

15 to 25 mgd; same as 0 to 1 mgd.

OXYGEN GAS ANALYZER -- For: Dissolved Oxygen, BOD.

Minimum

0 to 1 mgd; not required.

1 to 5 mgd; not required.

5 to 15 mgd; not required.

15 to 25 mgd; activated sludge plants only; polarographic cell type, portable, manual temperature compensation, altitude correction to 5000 feet, salinity scale, oxygen scale 0 to 15 ppm with 0.2 ppm graduations, and recorder output; extension handle; probe, BOD, non-stirring.

Optimum

0 to 1 mgd; all plant types; Polarographic cell type, portable, rechargeable nickel cadmium cells, recorder output, automatic temperature compensation, scale 0 to 10 and 0 to 20 ppm; 0.2 and 0.4 graduations respectively

and recorder output; extension handle; probe, BOD, stirring; probe, oxygen, field.

1 to 5 mgd; same as 0 to 1 mgd; plus probe, BOD, non-stirring.

5 to 15 mgd; same as 0 to 1 mgd; plus probe, BOD, non-stirring.

15 to 25 mgd; same as 0 to 1 mgd; plus analyzer similar to 15 to 25 mgd, minimum level; extension handle; probe, BOD non-stirring; probe, oxygen, field, 10 feet.

pH METER -- For: General Lab Use.

Minimum

0 to 1 mgd; direct reading, portable, battery or line operated, expanded scale, ranges 0 to 14 pH and any 1.4 pH increment, accuracy ±0.1 pH on 0 to 14 pH range, and ±0.01 pH on 1.4 pH span; with electrode holder; 160 oz. of 4.01 and 7.00 pH buffers; 100 ml. potassium chloride electrolyte.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd.

15 to 25 mgd; same as 0 to 1 mgd.

Optimum

0 to 1 mgd; digital indicating, gas ionization tube, ranges 0.00 to 14.00 pH, accuracy ±0.01 pH, manual and automatic temperature compensation, 0° to 100°C, with electrode support, 16 oz. of 4.01 and 7.00 pH buffers, 100 ml. of potassium chloride electrolyte.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd.

15 to 25 mgd; same as 0 to 1 mgd.

For continuous monitoring; one unit required for each location requiring continuous pH monitoring.

Minimum

All sizes; indicator plus remote sensing unit.

PUMP (VACUUM-PRESSURE) -- For: Suspended Solids, Volatile Suspended Solids, Dissolved Solids, Coliforms (Membrane Filter Method) Fecal Coliforms (Membrane Filter Method), Volatile Acids, Grease.

Minimum

All plant sizes; rotary, motor driven, free air capacity of 1.3 cu. ft. per minute, maximum pressure continuous 15 psig, intermittent 25 psig, maximum vacuum continuous 15 inches of mercury, intermittent 27 inches of mercury.

EFRIGERATOR -- For: General Lab Use.

Minimum

0 to 1 mgd; 5 cu. ft. capacity.

1 to 5 mgd; 13 cu. ft. capacity.

5 to 15 mgd; same as 1 to 5 mgd.

15 to 25 mgd; same as 1 to 5 mgd.

**SAFETY SHOWER** -- For: General Lab Use.

Minimum

All plant sizes; emergency, first aid, impeller action 8-inch shower head, chain pull.

Optimum

All plant sizes; Eye Fountain-Safety Shower Combination, chain pull, foot pedal operation for eye wash.

**SPECTROPHOTOMETER** -- For: MBAS, $NH_3$-N, $NO_3$-N, $PO_4$-Total, Heavy Metals, Chlorine Residual (not required for plants provided with continuous measurement of chlorine residual), sulfate.

Minimum

0 to 1 mgd; not required for chlorine residual or $NO_3$-N, except in Nitrogen removal processes; for all others: meter indicating with grating monochromator, fixed bandpass of 20 nm, wave length range of 340 to 600 nm, expandable to 950 nm with phototube and filter, wave length accuracy of ±2.5 nm, photometric accuracy of ±2.5% of full scale, colorimeter cells, 1/2 inch; for MBAS and $PO_4$-Total, include phototube, red sensitive, and filter, red stray light.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd.

15 to 25 mgd; same as 0 to 1 mgd, except required for all $NO_3$-N testing and chlorine residual, except if continuous chlorine residual measurement is provided.

Optimum

0 to 1 mgd; not required for chlorine residual or $NO_3$-N testing except in nitrogen removal processes for all others: meter indicating test tube type, 325 nm to 925 nm wave length range, 8 nm band pass, 8 inch meter with anti-parallel mirror, wavelength accuracy of ±1 nm, and precision of ±0.2 nm, photometer linearity ±0.5% at meter terminals and ±0.2% at recorder terminals, plus Cuvettes, rectangular, glass, 10 mm.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd.

15 to 25 mgd; same as 0 to 1 mgd, except required for $NO_3$-N and chlorine residual testing.

STERILIZER -- For: Coliform, Fecal Coliform, $PO_4$-Total (Optional).

Minimum

0 to 1 mgd; steam pressure, pot form, external heat, capacity 25 quarts.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd.

15 to 25 mgd; steam pressures pot form, electric, thermostatically controlled, capacity 831 cu. inches.

Optimum

0 to 1 mgd; steam pressure, single control, portable, electric, chamber 9 inches diameter by 16 inches deep.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; same as 0 to 1 mgd.

15 to 25 mgd; same as 0 to 1 mgd, plus ultraviolet sterilizer, portable.

STILL (WATER)(OR DEMINERALIZER) -- For: General Lab Use.

Minimum

0 to 1 mgd; demineralizer column holder; plus cartridges capacity of 1,500 grains of dissolved solids at end point of 50,000 ohms water resistance.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; electrically heated, 1 gallon per hour capacity.

15 to 25 mgd; same as 5 to 15 mgd.

Optimum

0 to 1 mgd; electrically heated, 2 gallon per hour capacity.

1 to 5 mgd; same as 0 to 1 mgd.

5 to 15 mgd; electrically heated, 5 gallon per hour capacity.

15 to 25 mgd; same as 5 to 15 mgd.

THERMOMETER -- For: Continuous Temperature Monitoring.

One required for each unit process requiring continuous temperature monitoring.

Minimum

All plant sizes; indicator, plus remote monitoring unit.

TITRATOR-AMPEROMETRIC -- For: Chlorine Residual.

Minimum

Not required.

Optimum

All plant sizes if provided with continuous chlorine residual measurement; electric, sensitivity of 0.01 ppm, with 200 ml. plastic sample container, 4 oz. pH4 and pH7 buffer and potassium iodide.

TURBIDIMETER -- For: Turbidity - Continuous Monitoring and/or Recording.

Minimum

All plant sizes; low range continuous flow nephelometer, sensitivity to 0.005 JTU, range from 0 to 30 JTU, plus remote indicator for operation up to 1,000 feet from master unit. If recorder is required, recorder should be 100 micro amp, DC.

Optimum

All plant sizes; "Surface Scatter" nephelometer similar to Hach Chemical Company Model 1889. If recorder is required, recorder should be 100 micro amp, DC.

WATER BATH -- For: Fecal Coliforms.

Minimum

0 to 1 mgd; not required.

1 to 5 mgd; not required.

5 to 15 mgd; stainless steel, triple wall construction, inside dimensions 14 inches x 10-1/2 inches x 7 inches.

15 to 25 mgd; same as 5 to 15 mgd.

## TABLE B–2

| MISCELLANEOUS EQUIPMENT ITEM | NUMBER OR AMOUNT REQUIRED | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MINIMUM | | | | OPTIMUM | | | |
| | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD |
| **BURNER:** | | | | | | | | |
| BUNSEN | 1 | 1 | 1 | 1 | | | | |
| BUNSEN, PILOT | | | | | | | 1 | 1 |
| FISCHER | | | | | 1 | 1 | 1 | 1 |
| **CLAMPS:** | | | | | | | | |
| BURET, DOUBLE | 1 | 1 | 2 | 2 | | | | |
| BURET, DOUBLE, NONOBSCURING, FOR 100 ML BURETS | | | | | 1 | 2 | 2-4 | 2-4 |
| EXTENSION, V-JAW, WIDE RANGE, ASBESTOS | 2 | 2-4 | 3-5 | 3-5 | 2 | 5-7 | 5-7 | 7-9 |
| SCREW, SLIDE JAW SLEEVES, 10¾" TOTAL LENGTH | | | | | 5-7 | 9-15 | 9-15 | 9-15 |
| PINCH, MOHR POST, PIVOT BAR, NONFERROUS | | | | | 5-7 | 9-15 | 9-15 | 9-15 |
| SCREW, OPEN SIDE | 5-7 | 5-7 | 5-7 | 5-7 | | | | |
| UTILITY, V-JAW, FIXED, WIDE RANGE, ASBESTOS JAW SLEEVES | | | | | | 5-7 | 5-7 | 7-9 |
| CLAMP HOLDER, ADJUSTABLE, JAW TO JAW CENTERS 2¾" | | | | | 3-5 | 5-7 | 5-7 | 9-15 |
| CLAMP HOLDER, FIXED, CASTALOY R | | | | | | 9-15 | 9-15 | 9-15 |
| CLAMP HOLDER, FIXED NONFERROUS | 2 | 2-4 | 5-7 | 5-7 | | | | |
| **CLOCKS:** | | | | | | | | |
| INTERVAL TIMER, SPRING DRIVEN METAL CASE ¼ TO 120 MIN. | 1 | 1 | 2 | 2 | | | | |
| INTERVAL TIMER, SPRING DRIVEN PLASTIC CASE ¼ TO 120 MIN. | | | | | 1 | 2 | 2 | 2-4 |
| INTERVAL TIMER & CONTROLLER, SPRING DRIVEN(1) 60 MIN, 10 AMP | | | 1 | 2 | | 1 | 1 | 1 |
| INTERVAL TIMER & CONTROLLER, ELECTRIC(1) 60 MIN, 6 AMP | | | | | 1 | 1 | 1 | 2 |
| STOPWATCH, 60 MINUTE | | | | | 1 | 1 | 1 | 1 |
| STOPWATCH HOLDER | | | | | 1 | 1 | 1 | 1 |
| **CORKBORER SET:** | | | | | | | | |
| SIZES 1-15, NICKEL PLATED BRASS | | | | | 1 | 1 | 1 | 1 |
| SIZES 1-6, NICKEL PLATED BRASS | | | 1 | 1 | | | | |
| **CORKBORER SHAPER**, LARGER SIZE | | | 1 | 1 | 1 | 1 | 1 | 1 |
| **DESICCATORS:** | | | | | | | | |
| ALUMINUM, 115mm | 1 | | 1 | 1 | | | | |
| ALUMINUM, 203mm | | 1 | 2 | 2 | | | | |
| SCHEIBLER, TABULATED, 250mm | | | | | 1 | 2 | 2 | 2 |
| SCHEIBLER, TABULATED, 150mm | | | | | 1 | 1 | 1 | 2 |
| **FIRST AID KIT** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **FORCEPS:** | | | | | | | | |
| BOTTLE, 300mm | | | | | | 1 | 1 | 1 |
| DISSECTING, CURVED | | | | | 2 | 2 | 2 | 2 |
| FLAT TIPPED, SS | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **FIRE EXTINGUISHER**, DRY CHEMICAL 5#ABC | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **KNIFE, GLASS CUTTING**, 25mm | | | | | 1 | 1 | 1 | 1 |

(1) NOT REQUIRED FOR PRIMARY OR POND TYPE PLANTS

## TABLE B–2

| MISCELLANEOUS EQUIPMENT ITEM | NUMBER OR AMOUNT REQUIRED | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MINIMUM | | | | OPTIMUM | | | |
| | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD |
| **PIPETTE:** | | | | | | | | |
| BASKET, POLYETHYLENE | | | | | 1 | 1 | 1 | 1 |
| WASHER, POLYETHYLENE | | | | | 1 | 1 | 1 | 1 |
| BOX, SS | | | | | 2 | 2-4 | 2-4 | 2-4 |
| **PUMP, FILTER, ASPIRATOR** | 1 | 1 | 1 | 2 | | 1 | 1 | 1 |
| **RINGS, CONCENTRIC, CAST IRON,** WITH CLAMP | | | | 1 | 2 | 2 | 2 | 2 |
| **RINGS, SUPPORT, IRON,** WITH CLAMP | | | | | | | | |
| 2 INCH | | | | | | | | 2 |
| 4 INCH | | | | | | | | 3-5 |
| 6 INCH | | | | | | | | 2 |
| **RINSER,** PRESSURE, 1 QT. | | | | | 1 | 1 | 1 | 1 |
| **SCORER,** GLASS | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG |
| **SIEVE,** 325 MESH(1) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **SPATULAS:** | | | | | | | | |
| CUSHION GRIP, SS 150mm | | | | | 2 | 2 | 2 | 2 |
| SEMI MICRO SCOOP STYLE | | | | | 2 | 2 | 2 | 2 |
| SEMI-MICRO, WEIGHING | | | | | 2 | 2 | 2 | 2 |
| SEMI-MICRO, DOUBLE BLADE | | | | | | | | |
| SCOOP STYLE SS | 2 | 2 | 5-7 | 5-7 | 9-15 | 9-15 | 9-15 | 9-15 |
| TEFLON COATED, SS, 150mm | | | | | 2 | 2 | 2 | 2 |
| VIBRATING, TEFLON COATED, SS | | | | | | | 1 | 1 |
| WOOD HANDLE, SS, 300 mm | | | 1 | 1 | 2 | 2 | 2 | 2 |
| WOOD HANDLE STEEL, 150mm | 1 | 1 | 1 | 2 | | | | |
| **SUPPORT:** | | | | | | | | |
| IMHOFF CONE(2) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| JAPANNED BASE, 5½"x9", ROD RUST PROOF, 24"x½" DIAM. | | | | | 1 | 2 | 2-4 | 2-4 |
| JAPANNED BASE, 5"x7", ROD RUST PROOF, 20"x3/8" DIAM. | 1 | 1 | 2-4 | 3-5 | | | | |
| BURET | | | 2 | 2 | 2 | 2 | 2-4 | 2-4 |
| LATTICE | | | | | | 1 | 1 | 1 |
| PIPETTE, POLYETHYLENE | | | | | 1 | 1 | 1 | |
| **TAPE DISPENSER** | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| **TANK STORAGE:** | | | | | | | | |
| DISTILLED WATER, 10 GAL. | | | 1 | 1 | 1 | | | |
| DISTILLED WATER, 25 GAL. | | | | | | 1 | 1 | 1 |
| **THERMOMETERS:** | | | | | | | | |
| -20°C TO 110°C | 1 | 1 | 1 | 2 | 2 | 2-4 | 2-4 | 3-5 |
| PRECISION GRADE, -1, TO 101°C | | | | | 1 | 1 | 1 | 1 |
| ARMOR | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| **TONGS:** | | | | | | | | |
| CRUCIBLE, SS | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| CRUCIBLE, MUFFLE (IF LAB IS EQUIPPED WITH MUFFLE FURNACE) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

(1) IF IODINE NUMBER IS TO BE RUN (2) FOR SETTLEABLE SOLIDS.

## TABLE B–3

| EXPENDABLE SUPPLIES ITEM | NUMBER OR AMOUNT REQUIRED | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MINIMUM | | | | OPTIMUM | | | |
| | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD |
| **APRON** | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 4 |
| **BAGS**, PLASTIC, 4x6 | | | 1 CASE | 1 CASE | | | 1 CASE | 1 CASE |
| **BEADS**: | | | | | | | | |
| GLASS, 4mm | 1 LB | 1 LB | 1 LB | 1 LB | | | | |
| BOROSILICATE | | | | | 1 LB | 1 LB | 1 LB | 1 LB |
| **BRUSHES**, GLASSWARE WASHING, ASSORTED | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **BULB**, RUBBER | | | | | 12 | 12 | 12 | 12 |
| **CLOTH**, DISPOSABLE | | | 2 BOXES | 4 BOXES | | | 6 BOXES | 6 BOXES |
| **CORKS**, ASSORTED | | | | 1 PKG | | | | 4 PKG |
| **CRUCIBLE HOLDER**, WALTER | 1 | 2 | 5 | 5 | 2 | 8 | 8 | 8 |
| **COTTON**, LONG FIBER | | | 1 LB | 1 LB | | | 1 LB | 1 LB |
| **FILTER PAPER**: | | | | | | | | |
| GLASS FIBER, 2.4 CM, REEVE ANGLE 934AH | 2 BOXES | 2 BOXES | 12 BOXES | 12 BOXES | 3 BOXES | 6 BOXES | 30 BOXES | 30 BOXES |
| MEMBRANE, 47mm, 0.45 MICRON, STERILE, GRIDDED | | | 2 PKG | 2 PKG | 1 PKG | 1 PKG | 2 PKG | 2 PKG |
| MEMBRANE, 25mm, 0.45 MICRON, STERILE, PLAIN(1) | | | | | 1 PKG | 1 PKG | 1 PKG | 1 PKG |
| WHATMAN, #30, 9 CM(2) | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 2 BOXES | 2 BOXES | 2 BOXES | 2 BOXES |
| WHATMAN, #1, 9 CM(2) | | | 1 BOX | 1 BOX | 2 BOXES | 2 BOXES | 2 BOXES | 2 BOXES |
| WHATMAN, #1PS, 9 CM(2)(3) | | | | | | | | 1 BOX |
| WHATMAN, #42, 9 CM(2) | | | | | 1 BOX | 1 BOX | 1 BOX | 1 BOX |
| **GLOVES**: | | | | | | | | |
| ASBESTOS(2)(4) | 1 PR | 1 PR | 1 PR | 1 PR | 1 PR | 1 PR | 1 PR | 1 PR |
| POLYETHYLENE | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG |
| **INK**, CERAMIC MARKING, COORS | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **PARAFILM**, 4" | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 1 BOX |
| **COVER GLASSES**, SQUARE NO. 1 22mm(5) | | | | | | | 1 OZ | 1 OZ |
| **GOGGLES**: | | | | | | | | |
| CHEMICAL | 1 PR | 1 PR | 1 PR | 1 PR | 1 PR | 1 PR | 1 PR | 1 PR |
| FACE SHIELD TYPE | | | | 1 | | | 1 | 1 |
| **PENCIL, WAX, HIGH TEMPERATURE**: | | | | | | | | |
| BLACK | 12 | 12 | 12 | 12 | 12 | 24 | 24 | 24 |
| RED | | | | | 12 | 12 | 12 | 12 |
| YELLOW | | | | | 12 | 12 | 12 | 12 |

(1) IF RINSER IS PROVIDED FROM TABLE B-2
(2) NOT NECESSARY FOR PRIMARY OR POND TYPE PLANTS
(3) FOR MBAS
(4) IF LAB IS EQUIPPED WITH MUFFLE FURNACE
(5) FOR MICROSCOPIC ANALYSIS.

## TABLE B–3

| EXPENDABLE SUPPLIES<br>ITEM | NUMBER OR AMOUNT REQUIRED | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MINIMUM | | | | OPTIMUM | | | |
| | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD |
| **PIPETTE, MANIPULATOR** | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 4 |
| **STOPPERS:** | | | | | | | | |
| KJELDAHL, 800 ML(1) | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG | 1 PKG |
| RUBBER, SOLID, ASSORTED | 4 LB | 4 LB | 4 LB | 4 LB | 4 LB | 6 LB | 6 LB | 6 LB |
| **TAPE**, LABELING, 1-INCH, WHITE | 2 RLS | 2 RLS | 4 RLS | 4 RLS | 6 RLS | 6 RLS | 6 RLS | 6 RLS |
| **TUBING:** | | | | | | | | |
| VACUUM, ¼" I.D. | 5 FT | 10 FT | 20 FT | 20 FT | 10 FT | 10 FT | 20 FT | 20 FT |
| VINYL, 3/16", I.D. | 50 FT | 50 FT | 50 FT | 50 FT | 50 FT | 50 FT | 50 FT | 50 FT |
| ¼", I.D. | | | | | 50 FT | 50 FT | 50 FT | 50 FT |
| 3/8", I.D. | | | | | 50 FT | 50 FT | 50 FT | 50 FT |
| **THIMBLE**, EXTRACTION, SINGLE THICKNESS(2) | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 1 BOX |

(1) FOR TOTAL KJELDAHL NITROGEN, (AMMONIA, PLUS ORGANIC)

(2) FOR GREASE DETERMINATION

## TABLE B–4

| GLASS AND PLASTICWARE ITEM | NUMBER OR AMOUNT REQUIRED |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
|  | MINIMUM |  |  |  | OPTIMUM |  |  |  |
|  | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD |
| **BEAKERS:** |  |  |  |  |  |  |  |  |
| LOW FORM BOROSILICATE: |  |  |  |  |  |  |  |  |
| 50 ML |  |  |  | 2 | 3-5 | 3-5 | 3-5 | 3-5 |
| 100 ML |  |  |  | 2 |  |  |  |  |
| LOW FORM BORSILICATE WITH TEFLON RIM: |  |  |  |  |  |  |  |  |
| 100 ML |  |  |  |  | 3-5 | 5-7 | 5-7 | 5-7 |
| 250 ML |  |  |  |  | 3-5 | 5-7 | 5-7 | 5-7 |
| 400 ML |  |  |  |  | 3-5 | 3-5 | 3-5 | 5-7 |
| 600 ML |  |  |  |  | 3-5 | 3-5 | 5-7 | 5-7 |
| 1,000 ML |  |  |  |  | 3-5 | 3-5 | 3-5 | 5-7 |
| LOW FORM POLYPROPYLENE: |  |  |  |  |  |  |  |  |
| 50 ML | 2 | 2 | 2-4 | 2-4 | 3-5 | 3-5 | 3-5 | 5-7 |
| 100 ML | 2 | 3-5 | 4-6 | 5-7 | 3-5 | 5-7 | 5-7 | 5-7 |
| 250 ML | 2 | 3-5 | 4-6 | 5-7 | 3-5 | 5-7 | 5-7 | 5-7 |
| 600 ML | 2 | 2 | 2-4 | 3-5 | 3-5 | 3-5 | 3-5 | 3-5 |
| 1,000 ML | 1 | 1 | 2 | 2-4 | 3-5 | 3-5 | 3-5 | 5-7 |
| **BOTTLES** |  |  |  |  |  |  |  |  |
| BOD, FLINT 300 ML | 12-24 | 48-60 | 66-78 | 66-78 | 24-36 | 48-60 | 66-78 | 66-78 |
| MILK DILUTION, GRADUATED | 42-54 | 42-54 | 42-54 | 42-54 | 42-54 | 42-54 | 42-54 | 42-54 |
| WIDE MOUTH POLYPROPYLENE |  |  |  |  |  |  |  |  |
| 4 OZ |  |  |  |  | 9-15 | 9-15 | 9-15 | 9-15 |
| 8 OZ | 9-15 | 9-15 | 9-15 | 9-15 | 9-15 | 9-15 | 9-15 | 9-15 |
| 16 OZ |  |  |  |  | 9-15 | 9-15 | 9-15 | 9-15 |
| 32 OZ |  |  |  |  | 9-15 | 9-15 | 9-15 | 9-15 |
| DROPPING, FLINT, 1 OZ. | 6-12 | 6-12 | 6-12 | 6-12 | 6-12 | 6-12 | 9-15 | 9-15 |
| ASSORTED GLASS FOR SAMPLING AND REAGENTS |  |  |  |  |  |  |  |  |
| 125 ML | 2 | 2 | 2-4 | 3-5 | 2-4 | 2-4 | 3-5 | 3-5 |
| 250 ML | 2 | 2 | 2-4 | 3-5 | 2-4 | 2-4 | 3-5 | 3-5 |
| 500 ML | 2 | 2 | 2-4 | 3-5 | 2-4 | 2-4 | 3-5 | 3-5 |
| 1,000 ML | 1 | 1 | 2 | 2-4 | 2 | 2 | 2-4 | 3-5 |
| 1 GAL | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 |
| 2 GAL |  |  |  |  |  |  | 1 | 1 |
| 5 GAL |  |  |  |  |  |  | 1 | 1 |
| **BURETS:** |  |  |  |  |  |  |  |  |
| SCHELLBACH, 50 ML, TEFLON STOPCOCK |  |  |  |  | 2 | 2 | 2 | 2 |
| ASSEMBLY, AUTOMATIC, 50 ML |  |  |  |  |  | 1 | 1 | 1 |
| GEISSLER, TEFLON STOPCOCK, 50 ML | 1 | 2 | 2 | 2 |  |  |  |  |
| MICRO, CLASS A, TEFLON STOPCOCK, 5 ML |  |  |  |  |  |  |  |  |
| MICRO, RESERVOIR, CLASS A, TEFLON STOPCOCK, 5 ML | 1(1) | 1(1) | 1 | 1 | 1 | 1 | 1 | 1 |

(1) REQUIRED FOR CHLORIDE DETERMINATION

## TABLE B–4

| GLASS AND PLASTICWARE ITEM | NUMBER OR AMOUNT REQUIRED | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MINIMUM | | | | OPTIMUM | | | |
| | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD |
| **BULBS, KJELDAHL**[1] | | | | | | | | |
| CONNECTING | 2 | 2 | 3-5 | 3-5 | 2-4 | 2-4 | 4-6 | 2-6 |
| DELIVERY | 2 | 2 | 3-5 | 3-5 | 2-4 | 2-4 | 4-6 | 4-6 |
| **CARBOY, BOROSILICATE** | | | | | | | | |
| 5 GAL. | 1 | 1 | 2 | 2 | | | | |
| 12 GAL. | | | | | 1 | 2 | 2 | 2 |
| **CELL, WATER COUNTING**[2] | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| **CONDENSER**, REFLUX, FREDRICHS[3] | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 |
| **CONE**, IMHOFF, STYRENE[4] | 2 | 2 | 2 | 2-4 | 2 | 2 | 3-5 | 5-7 |
| **CRUCIBLE** | | | | | | | | |
| FILTERING, HIGH FORM, FRITTED GLASS MEDIUM, 30 ML[5] | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| GOOCH, NO. 4 | 9-12 | 15-21 | 35-42 | 30-42 | 15-21 | 30-42 | 48-60 | 48-60 |
| **CYLINDER, GRADUATED:** | | | | | | | | |
| BOROSILICATE | | | | | | | | |
| 10 ML | | | | | 2 | 2 | 2 | 2-4 |
| 25 ML | | | | | 2 | 2 | 3-5 | 3-5 |
| 50 ML | | | | | 3-5 | 3-5 | 5-7 | 5-7 |
| 100 ML | | | | | 3-5 | 5-7 | 5-7 | 7-9 |
| 250 ML | | | | | 3-5 | 3-5 | 5-7 | 5-7 |
| 500 ML | | | | | 2 | 2 | 3-5 | 3-5 |
| 1,000 ML | | | | | 2 | 2 | 2 | 3-5 |
| POLYPROPYLENE | | | | | | | | |
| 10 ML | | | | | | | | 2 |
| 25 ML | 1 | 2 | 3-5 | 3-5 | 3-5 | 3-5 | 3-5 | 3-5 |
| 50 ML | 1 | 1 | 3-5 | 3-5 | 5-7 | 7-9 | 7-9 | 7-9 |
| 100 ML | 1 | 1 | 3-5 | 3-5 | 7-9 | 9-11 | 9-11 | 9-11 |
| 250 ML | 2 | 2-4 | 4-6 | 4-6 | 5-7 | 7-9 | 7-9 | 7-9 |
| 500 ML | 1 | 1 | 2 | 2-4 | 2 | 2 | 3-5 | 5-7 |
| 1,000 ML | 2 | 2 | 3-5 | 5-7 | 5-7 | 7-9 | 7-9 | 7-9 |
| **DISH:** | | | | | | | | |
| EVAPORATING: | | | | | | | | |
| STANDARD FORM, NO. 1 | | | | | 15-24[5] | 30-42[7] | 30-42 | 30-42 |
| STANDARD FORM, NO. 0 | 6-12[6] | 9-15[7] | 9-15 | 9-15 | | | | |
| LOW FORM, NO. 7 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| PETRI, STERILE, PLASTIC, 50mm | | | 1 CASE | 1 CASE | 1 CASE | 1 CASE | 1 CASE | 1 CASE |

(1) FOR TOTAL KJELDAHL NITROGEN, (AMMONIA, PLUS ORGANIC).
(2) FOR MICROSCOPIC ANALYSIS.
(3) FOR COD TESTS.
(4) FOR SETTLEABLE SOLIDS.
(5) FOR VOLITILE ACIDS.
(6) 4-8 FOR PRIMARY OR POND TYPE PLANTS.
(7) 6-9 FOR PRIMARY OR POND TYPE PLANTS.

## TABLE B–4

| GLASS AND PLASTICWARE ITEM | NUMBER OR AMOUNT REQUIRED | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MINIMUM | | | | OPTIMUM | | | |
| | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD |
| **EXTRACTION ASSEMBLY**, SOXHLET, MEDIUM(1) | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| **FILTER HOLDER, MEMBRANE**, 47mm | | | 1 | 1 | 1 | 1 | 2 | 2 |
| **FLASKS:** | | | | | | | | |
| BOROSILICATE: | | | | | | | | |
| ERLENMEYER: | | | | | | | | |
| WIDE NECK | | | | | | | | |
| 250 ML | | | 2 | 2 | 3-5 | 3-5 | 3-5 | 3-5 |
| 500 ML | 2 | 2 | 3-5 | 5-7 | 3-5 | 5-7 | 5-7 | 5-7 |
| NARROW NECK, TEFLON RIM: | | | | | | | | |
| 50 ML | | | | | | | | 2 |
| 125 ML | | | | | 2 | 2 | 2 | 3-5 |
| 250 ML | | | | | 2 | 2 | 3-5 | 5-7 |
| 500 ML | | | | | 2 | 2 | 3-5 | 5-7 |
| 1,000 ML | | | | | 1 | 1 | 2 | 3-5 |
| EXTRACTION, $: | | | | | | | | |
| 500 ML(1) | 1 | 1 | 1 | 1 | 2 | 2 | 3-5 | 5-7 |
| VACUUM: | | | | | | | | |
| 500 ML | | | | | 2 | 2 | 2 | 2 |
| 1,000 ML | | | | | 2 | 7-9 | 7-9 | 7-9 |
| VOLUMETRIC, $, STOPPER, CLASS A | | | | | | | | |
| 50 ML | | | | | 2 | 2 | 2 | 3-5 |
| 100 ML | | | | | 3-5 | 3-5 | 5-7 | 5-7 |
| 250 ML | | | | | 2 | 3-5 | 3-5 | 5-7 |
| 500 ML | | | | | 2 | 3-5 | 3-5 | 5-7 |
| 1,000 ML | | | | | 2 | 2 | 3-5 | 5-7 |
| KJELDAHL; LONG NECK(2) | | | | | | | | |
| 800 ML | 2 | 2 | 3-5 | 3-5 | 2-4 | 2-4 | 4-6 | 4-6 |
| POLYPROPYLENE: | | | | | | | | |
| VACCUM: | | | | | | | | |
| 500 ML | 1 | 2 | 4-6 | 4-6 | | | | |
| VOLUMETRIC: | | | | | | | | |
| 100 ML | | 1 | 2 | 2 | | | | |
| 250 ML | 1 | 1 | 2-4 | 2-4 | | | | |
| 500 ML | 1 | 1 | 2-4 | 2-4 | | | | |
| 1,000 ML | 1 | 1 | 2 | 2-4 | | | | |
| **FUNNEL:** | | | | | | | | |
| ANALYTICAL: | | | | | | | | |
| PYREX: | | | | | | | | |
| LONG STEM, | | | 1 | 2 | 1 | 2-4 | 2-4 | 3-5 |
| SHORT STEM | 1 | | | | 1 | 2 | 2 | 3-5 |

(1) FOR GREASE DETERMINATIONS.

(2) FOR TOTAL KJELDAHL NITROGEN, (AMMONIA, PLUS ORGANIC)

## TABLE B–4

| GLASS AND PLASTICWARE ITEM | NUMBER OR AMOUNT REQUIRED | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MINIMUM | | | | OPTIMUM | | | |
| | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD |
| **FUNNEL: (Cont'd)** | | | | | | | | |
| ANALYTICAL: (Cont'd) | | | | | | | | |
| POLYPROPYLENE, 100 mm | | 1 | 1 | 2 | | | | |
| POWDER: | | | | | | | | |
| POLYPROPYLENE, 100mm | | | | | | | | 2 |
| BOROSILICATE, 100mm | | | | | | | | 1 |
| SEPARATING: | | | | | | | | |
| SQUIBB: | | | | | | | | |
| POLYPROPYLENE, 250 ML | | | | | | | | 2 |
| BOROSILICATE, TEFLON STOPCOCK, 250 ML | | | | 1 | | | | 2 |
| **LADLE:** | | | | | | | | |
| POLYETHYLENE: | | | | | | | | |
| 50 ML | | | | | 2 | 2 | 3-5 | 3-5 |
| 250 ML | 1 | 1 | 1 | 2 | 2 | 2 | 3-5 | 3-5 |
| 600 ML | | | | | 2 | 2 | 2-4 | 3-5 |
| **PIPETTES:** | | | | | | | | |
| GLASS: | | | | | | | | |
| MOHR, BOROSILICATE: | | | | | | | | |
| 1 IN 1/100 ML | | | | | 4-6 | 5-7 | 5-7 | 7-9 |
| 5 IN 1/10 ML | | | | | 4-6 | 5-7 | 5-7 | 5-7 |
| 10 IN 1/10 ML | | | | | 4-6 | 5-7 | 5-7 | 5-7 |
| 25 IN 1/10 ML | | | | | 2 | 2 | 3-5 | 5-7 |
| 50 IN 1/5 ML | | | | | 1 | 2 | 2 | 3-5 |
| PASTEUR, DISPOSABLE | | | | | 1 PKG | 1 PKG | 1 PKG | 1 PKG |
| SEROLOGICAL, COTTON PLUGGED, STERILE: | | | | | | | | |
| 1 IN 1/100 ML | | | | | 1 PKG | 1 PKG | 1 PKG | 1 PKG |
| 5 IN 1/10 ML | | | | | 1 PKG | 1 PKG | 1 PKG | 1 PKG |
| 10 IN 1/10 ML | | | | | 1 PKG | 1 PKG | 1 PKG | 1 PKG |
| VOLUMETRIC, BOROSILICATE, CLASS A: | | | | | | | | |
| 1 ML | | | | | 3-5 | 5-7 | 5-7 | 5-7 |
| 5 ML | | | | | 3-5 | 5-7 | 5-7 | 5-7 |
| 10 ML | | | | | 3-5 | 5-7 | 5-7 | 5-7 |
| 25 ML | | | | | 2 | 3-5 | 3-5 | 5-7 |
| 50 ML | | | | | | 1 | 2 | 3-5 |
| PLASTIC: | | | | | | | | |
| MOHR, POLYPROPYLENE: | | | | | | | | |
| 1 IN 1/100 ML | 2 | 2 | 3-5 | 3-5 | 2 | 2 | 2 | 3-5 |
| 5 IN 1/10 ML | 2 | 5-7 | 7-9 | 7-9 | 9-11 | 9-11 | 9-11 | 9-11 |
| 10 IN 1/10 ML | 4-6 | 4-6 | 5-7 | 5-7 | 2 | 2 | 2 | 3-5 |

## TABLE B–4

| GLASS AND PLASTICWARE ITEM | NUMBER OR AMOUNT REQUIRED |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
|  | MINIMUM |  |  |  | OPTIMUM |  |  |  |
|  | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD |
| **PIPETTES: (Cont'd)** |  |  |  |  |  |  |  |  |
| PLASTIC: (Cont'd) |  |  |  |  |  |  |  |  |
| SEROLOGICAL, COTTON PLUGGED, STERILE: |  |  |  |  |  |  |  |  |
| 1 IN 1/100 ML | 1 PKG | 1 PKG | 1 PKG | 1 PKG |  |  |  |  |
| 5 IN 1/10 ML | 1 PKG |  |  |  |  |  |  |  |
| 10 IN 1/10 ML |  | 1 PKG | 1 PKG | 1 PKG |  |  |  |  |
| VOLUMETRIC, POLYPROPYLENE: |  |  |  |  |  |  |  |  |
| 5 ML | 2 | 2 | 5-7 | 5-7 |  |  |  |  |
| 10 ML | 2 | 2 | 5-7 | 5-7 |  |  |  |  |
| DROPPING WITH BULB, POLYETHYLENE, 110mm | 6-9 | 9-15 | 9-15 | 9-15 | 9-15 | 9-15 | 9-15 | 9-15 |
| **PIPETTE JAR** |  |  |  |  | 1 | 1 | 1 | 1 |
| **RODS:** |  |  |  |  |  |  |  |  |
| GLASS, FLINT, 6mm |  |  |  |  | ½ LB | 1 LB | 1 LB | 1 LB |
| STIRRING, GLASS, 250mm x 6mm | 9-15 | 9-15 | 9-15 | 9-15 |  |  |  |  |
| **SLIDES, MICROSCOPE(1)** | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 1 BOX | 2 BOXES | 2 BOXES |
| **TUBES, NESSLER, TALLFORM(2)** | 1 SET | 1 SET | 1 CASE | 1 CASE | 1 SET | 1 SET | 1 CASE | 1 CASE |
| **TUBING:** |  |  |  |  |  |  |  |  |
| CONNECTOR, POLYETHYLENE |  |  | 6-8 | 6-8 | 9-11 | 11-13 | 11-13 | 11-13 |
| GLASS, FLINT, ASSORTED | 1 LB | 1 LB | 3 LB | 3 LB | 4 LB | 6 LB | 6 LB | 6 LB |
| "T", POLYETHYLENE, ¼" ID |  |  | 4-6 | 4-6 | 3-5 | 6-8 | 7-9 | 7-9 |

(1) FOR MICROSCOPIC ANALYSIS.

(2) FOR TOTAL KJELDAHL NITROGEN, (AMMONIA, PLUS ORGANIC)

## TABLE B–5

| TEST KIT ITEM | NUMBER OR AMOUNT REQUIRED | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MINIMUM | | | | OPTIMUM | | | |
| | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD | 0-1 MGD | 1-5 MGD | 5-15 MGD | 15-25 MGD |
| **ALKALINITY TEST KIT** | 1 | | | | | | | |
| **CHLORINE TEST KIT**(1) | 1 | 1 | 1 | | | | | |
| **COLIFORM TEST KIT** | | | | | | | | |
| PRESUMPTIVE | 50 | 50 | | | | | | |
| CONFIRMED | 50 | 50 | | | | | | |
| **NITRATE-NITRITE TEST KIT**(2) | 1 | 1 | 1 | | | | | |
| PRETREATMENT KIT(2) | 1 | 1 | 1 | | | | | |

(1) NOT REQUIRED IF SPECTROPHOTOMETER HAS BEEN PROVIDED.

(2) REQUIRED FOR ACTIVATED SLUDGE PROCESS ONLY. NOT REQUIRED IF SPECTROPHOTOMETER HAS BEEN PROVIDED.

## TABLE B-6

## CHEMICAL NEEDS

| Test | Chemical Requirement[1] |
|---|---|
| | Common Standard Stock Reagents: |
| | Sodium Hydroxide - 15N<br>Sodium Hydroxide Pellets (625 gm) |
| | Sulfuric Acid - 10N<br>Sulfuric Acid, Conc. (140 ml) |
| | Hydrochloric Acid - 6N<br>Hydrochloric Acid, Conc. (500 ml) |
| Acidity (Potentiometric Titration Method) | Sodium Hydroxide Standard Titrant, 0.02N;<br>Stock Sodium Hydroxide<br>Potassium Biphtalate (4.085 gm) |
| Alkalinity (Potentiometric Titration Method) | Sulfuric or Hydrochloric Acid Standard Titrant, 0.02N;<br>Stock Sulfuric or Hydrochloric Acid<br>Sodium Carbonate (1.06 gm) |
| DO (Azide Modification of Iodometric Method) | Manganous Sulfate (480 gm)<br>Sodium Hydroxide (500 gm)<br>Potassium Iodide (150 gm)<br>Sodium Azide (10 gm)<br>Sulfuric Acid, Conc. (100 ml)<br>Sodium Thiosulfate Titrant, 0.025N;<br>Sodium Thiosulfate (186.15 gm)<br>Potassium Biniodate (4.873 gm)<br>Potassium Iodide (2 gm)<br>Sulfuric Acid (200 ml)<br>Potato Starch (10 gm)<br>Chloroform (5 ml) |
| For Activated Sludge | Sulfamic Acid (32 gm)<br>Copper Sulfate (50 gm)<br>Ascetic Acid, Conc. (500 ml) |

| Test | Chemicals |
|---|---|
| BOD | Phosphate Buffer Solution;<br>Potassium Dihydrogen Phosphate (8.5 gm);<br>Dipotassium Hydrogen Phosphate (21.75 gm);<br>Disodium Hydrogen Phosphate Heptahydrate (33.5 gm)<br>Ammonium Chloride (1.7 gm)<br>Magnesium Sulfate (22.5 gm)<br>Calcium Chloride (27.5 gm)<br>Ferric Chloride (0.25 gm)<br>Sodium Sulfite (1.575 gm) |
| COD | Potassium Dichromate, 0.025N;<br>Potassium Dichromate (12.259 gm)<br>Sulfuric Acid Reagent;<br>Sulfuric Acid, Conc. (2.25 l)<br>Silver Sulfate (23.5 gm)<br>Ferrous Ammonium Sulfate, 0.1N;<br>Ferrous Ammonium Sulfate (39 gm)<br>Sulfuric Acid, Conc. (20 ml)<br>Ferroin Indicator;<br>1,10-Phenanthroline Monohydrate (1.485 gm)<br>Ferrous Sulfate (0.695 gm)<br>Mercuric Sulfate, Analytical Grade Crystals (40 gm) |
| Chloride (Mercuric Nitrate Method)<br>Note: Disregard if test kit is provided. | D.B. Mixed Indicator;<br>Diphenylcarbazone Powder (5 gm)<br>Bromphenol Blue Powder (0.5 gm)<br>Ethyl Alcohol - 95% (750 ml)<br>Sodium Chloride Solution;<br>Sodium Chloride (0.08241 gm)<br>Mercuric Nitrate Titrant;<br>Mercuric Nitrate (50g)<br>Nitric Acid (5 ml)<br>Sodium Hydroxide, 0.1N;<br>Stock Sodium Hydroxide |
| Ammonia Nitrogen | Ammonium Chloride (3.819 gm)<br>Boric Acid (if more than 5 mg/l $NH_3$-N)(20 gm)<br>Mixed Indicator (if more than 5 mg/l $NH_3$-N);<br>Methyl Red - 0.2% (1 gm)<br>Ethyl Alcohol - 95% (1 L)<br>Nessler Reagent;<br>Mercuric Iodide (100 gm)<br>Potassium Iodide (70 gm)<br>Sodium Hydroxide Pellets (160 gm) |

| Test | Chemicals |
|---|---|
| | Borate Buffer;<br>Stock Sodium Hydroxide<br>Sodium Tetraborate (5 gm)<br>Sulfuric Acid Titrant, 0.02N:<br>Stock Sulfuric Acid<br>Sodium Carbonate (1.06 gm)<br>Sodium Hydroxide, 1N;<br>Stock Sodium Hydroxide<br>Dechlorinating Reagent;<br>Sodium Thiosulfate (3.5 gm) |
| Nitrate Nitrogen (Brucine Method)<br>Note: Disregard if test kit is provided. | Sodium Chloride (300 gm)<br>Sulfuric Acid, Conc. (500 ml)<br>Brucine-Sulfanilic Acid;<br>Brucine Sulfate (1 gm)<br>Sulfnilic Acid (0.1 gm)<br>Hydrochloric Acid, Conc. (3 ml)<br>Potassium Nitrate (0.7211 gm)<br>Acetic Acid, Conc. (200 ml) |
| Organic Nitrogen | Phosphate Buffer Solution, 0.5 M;<br>Anhydrous Potassium Dihydrogen Phosphate (14.3 gm)<br>Anhydrous Dipotassium Hydrogen Phosphate (68.8 gm)<br>Mercuric Sulfate Solution;<br>Red Mercuric Oxide (8 gm)<br>Stock Sulfuric Acid<br>Sulfuric Acid - Mercuric Sulfate-Potassium Sulfate Solution;<br>Potassium Sulfate (267 gm)<br>Sulfuric Acid, Conc. (400 ml)<br>Sodium Hydroxide - Sodium Thiosulfate Solution;<br>Sodium Hydroxide Pellets (500 gm)<br>Sodium Thiosulfate (25 gm)<br>Phenolphthalein Indicator (2)<br>Mixed Indicator;<br>Methyl Red - 0.2% (1 gm)<br>Methyl Blue - 0.2% (1 gm)<br>Ethyl Alcohol - 95% (1 L)<br>Indicating Boric Acid Solution;<br>Boric Acid (20 gm)<br>Sulfuric Acid Titrant, 0.02N;<br>Stock Sulfuric Acid |
| Total Phosphorous, Polyphosphate and Ortho Phosphate | Sulfuric Acid, 5N;<br>Stock Sulfuric Acid<br>Potassium Antimonyl Tartrate (1.3715 gm) |

| Test | Chemicals |
|---|---|
|  | Ammonium Molybdate (20 gm)<br>Ascorbic Acid (1.76 gm)<br>Sulfuric Acid, Conc. (310 ml)<br>Ammonium Persulfate (40 gm)<br>Potassium Dihydrogen Phosphate (0.2197 gm) |
| Volatile Acids | Silicic Acid, 100 Mesh (10 gm)<br>Chloroform - Butanol Reagent;<br>Chloroform (300 ml)<br>n-Butanol (100 ml)<br>Stock Sulfuric Acid<br>Thymol Blue Indicator(2)<br>Phenolphtalein Indicator(2) |
| Heavy Metals | Common Reagents for all heavy metals:<br>Sulfuric Acid, (2.25 L)<br>Nitric Acid (2.25 L)<br>Hydrogen Peroxide - 30% (1 L)<br>Perchloric Acid - 60% (2.25 L)<br>Ammonium Acetate (400 gm) |
| Cadmium | Cadmium Metal - Pure (0.1 gm)<br>Hydrochloric Acid, Conc. (5 ml)<br>Potassium Sodium Tartrate (50 gm)<br>Dithizone - ACS Grade (0.1 gm)<br>Carbon Tetrachloride (1 L)<br>Stock Sodium Hydroxide<br>Calcium Oxide (10 gm)<br>Diphenylthiocarbozone (0.1 gm)<br>Chloroform (100 ml)<br>Ammonium Hydroxide, Conc. (900 ml)<br>Dimethylglyoxime (1 gm)<br>Ethyl Alcohol - 95% (100 ml) |
| Chromium | Potassium Dichromate (0.1414 gm)<br>Methyl Orange Indicator(4)<br>Ammonium Hydroxide, Conc. (100 ml)<br>Phosphoric Acid - 85% (0.3 ml)<br>Potassium Permanganate (4 gm)<br>Sodium Azide (0.5 gm)<br>Diphenylcarbazide (0.25 gm)<br>Acetone (50 ml)<br>Chloroform (100 ml)<br>Cupferron (5 gm)<br>Sodium Nitrite (0.1 gm) |

| Test | Chemicals |
|---|---|
| Copper | Copper Metal - Polished Electrolytic |
| | Wire or Foil (0.2 gm) |
| | Hydroxylamine - Hydrochloride (50 gm); |
| | Sodium Citrate (150 gm) |
| | Chloroform (100 ml) |
| | 2,9-Dimethyl-1, 10-Phenanthroline-Hemihydrate (0.1 gm) |
| | Methyl Alcohol (100 ml) |
| | Congo Red pH Paper (1 foot) |
| | Ammonium Hydroxide, Conc. (400 ml) |
| Iron | Iron - Electrolytic Iron Wire (0.2 gm); |
| | Hydroxylamine - Hydrochloride (50 gm); |
| | Sodium Acetate (200 gm) |
| | 1,10- Phenanthroline (0.5 gm) |
| | Hydrochloric Acid, Conc. (100 ml) |
| | Isopropyl Ether (100 ml) |
| | Stock Sulfuric Acid |
| Lead | Lead Metal - Pure (100 mg) |
| | Phenolphthalein Indicator (2) |
| | Ammonium Hydroxide, Conc. (250 ml) |
| | Hydrazine Acetate Solution |
| | Hydrazine - 64% (15 ml) |
| | Acetic Acid (50 ml) |
| | Sodium Tartrate (10 gm) |
| | Tartaric Acid (50 gm) |
| | Dithizone Crystals (0.25 gm) |
| | Chloroform (1 L) |
| | Carbon Tetrachloride, ACS Grade (1 L) |
| | Hydrochloric Acid, Conc. (100 ml) |
| | Calcium Oxide (10 gm) |
| | Sodium Bicarbonate (10 gm) |
| | Thymol Blue Indicator (2) |
| | Potassium Cayanide (10 gm) |
| | Sodium Sulfite (10 gm) |
| Manganese | Potassium Permanganate (1.8 gm) |
| | Sodium Oxalate (10 gm) |
| | Sodium Bisulfite (10 gm) |
| | Phosphoric Acid (400 ml) |

| Test | Chemicals |
|---|---|
|  | Silver Nitrate (1.7 gm)<br>Ammonium Persulfate (25 gm)<br>Sodium Nitrite (5 gm) |
| Nickel (Heptoxime Method) | Nickel Sulfate (0.4479 gm)<br>Bromine (100 gm)<br>Ammonium Hydroxide, Conc. (10 ml)<br>1,2-Cycloheptanedionedioxime (0.1 gm)<br>Ethyl Alcohol (500 ml)<br>Sodium Tartrate (10 gm)<br>Methyl Orange Indicator (2)<br>Stock Sodium Hydroxide<br>Acetic Acid, Conc. (25 ml)<br>Cupferron (1 gm)<br>Chloroform (500 ml)<br>Hydroxylamine-Hydrochloride (10 gm)<br>Hydrochloric Acid, Conc. (85-5 ml) |
| Zinc | Zinc Metal (1 gm)<br>Methyl Red Indicator (2)<br>Sodium Citrate (10 gm)<br>Ammonium Hydroxide (100 ml)<br>Potassium Cyanide (5 gm)<br>Acetic Acid, Conc. (25 ml)<br>Carbon Tetrachloride (500 ml)<br>Diethanolamine (4 gm)<br>Carbon Disulfide (1 ml)<br>Methyl Alcohol (40 ml)<br>Diphenylthiocarbozone (50 gm)<br>Hydrochloric Acid, Conc. (50 ml)<br>Sodium Sulfide (3 gm)<br>Hydrogen Sulfide |
| Grease | Hydrochloric Acid, Conc. (50 ml)<br>n-Hexane (1 L)<br>Diatomaceous-Silica Filter Aid (1 L);<br>Magnesium-Sulfate Heptahydrate (200 gm) |
| Iodine Number | Hydrochloric Acid, Conc. (55 ml)<br>Iodine (127 gm)<br>Potassium Iodide (191 gm)<br>Sodium Thiosulfate, 0.1N;<br>Sodium Thiosulfate (24.82 gm)<br>Sodium Carbonate (0.1 gm)<br>Copper Metal (0.2 gm)<br>Nitric Acid, Conc. (5 ml)<br>Strong Ammonia Solution (50 ml)<br>Acetic Acid (50 ml)<br>Potassium Iodide (100 gm)<br>Potato Starch (10 gm) |

| Test | Chemicals |
|---|---|
| Calcium Content | Potassium Hydroxide, 8N; |
| | Potassium Hydroxide (448 gm) |
| | Calver II Indicator Powder (350 gm)(3) |
| | Titraver Solution (1L)(3) |
| MBAS | Standard Alkyl Benzene Sulfonate (ABS), 1 gm(4) |
| | Phenolphthalein Indicator(2) |
| | Stock Sodium Hydroxide |
| | Stock Sulfuric Acid |
| | Chloroform (50 ml) |
| | Methylene Blue Reagent; |
| | Methylene Blue (0.1 gm) |
| | Sulfuric Acid, Conc. (6.8 ml) |
| | Monosodium Dihydrogen Phosphate Monohydrate (50 gm) |
| | Wash Solution; |
| | Sulfuric Acid, Conc. (6.8 ml) |
| | Monosodium Dihydrogen Phosphate Monohydrate (50 gm) |
| Hardness (EDTA Method) | Buffer Solution; |
| | Ammonium Cloride (16-9 gm) |
| | Ammonium Hydroxide, Conc. (143 ml) |
| | EDTA, Magnesium Salt (1.25 gm) |
| | Eriochrome Black T Indicator; |
| | Eriochrome Black T Dye (0.5 gm) |
| | Hydroxylamine Hydrochloride (4.5 gm) |
| | Ethyl Alcohol - 95% (100 ml) |
| | Standard EDTA Titrant, 0.01M; |
| | EDTA (3.723 gm) |
| | Anhydrous Calcium Carbonate (1 gm) |
| | Stock Hydrochloric Acid; |
| | Methyl Red Indicator(2) |
| | Ammonium Hydroxide, Conc. (200 ml) |

Footnotes:

(1) Unless otherwise noted, reagent grade chemicals are required.

(2) Total amount required, for all testing, including backup stock is 1 pint.

(3) Similar to that manufactured by Hach Chemical Co., Ames, Iowa.

(4) Obtain from Soap & Detergent Association.

Method of Calculation of Suggested Chemical Requirement:

1. Determine test to be run from Testing Guidelines, Chapter II.

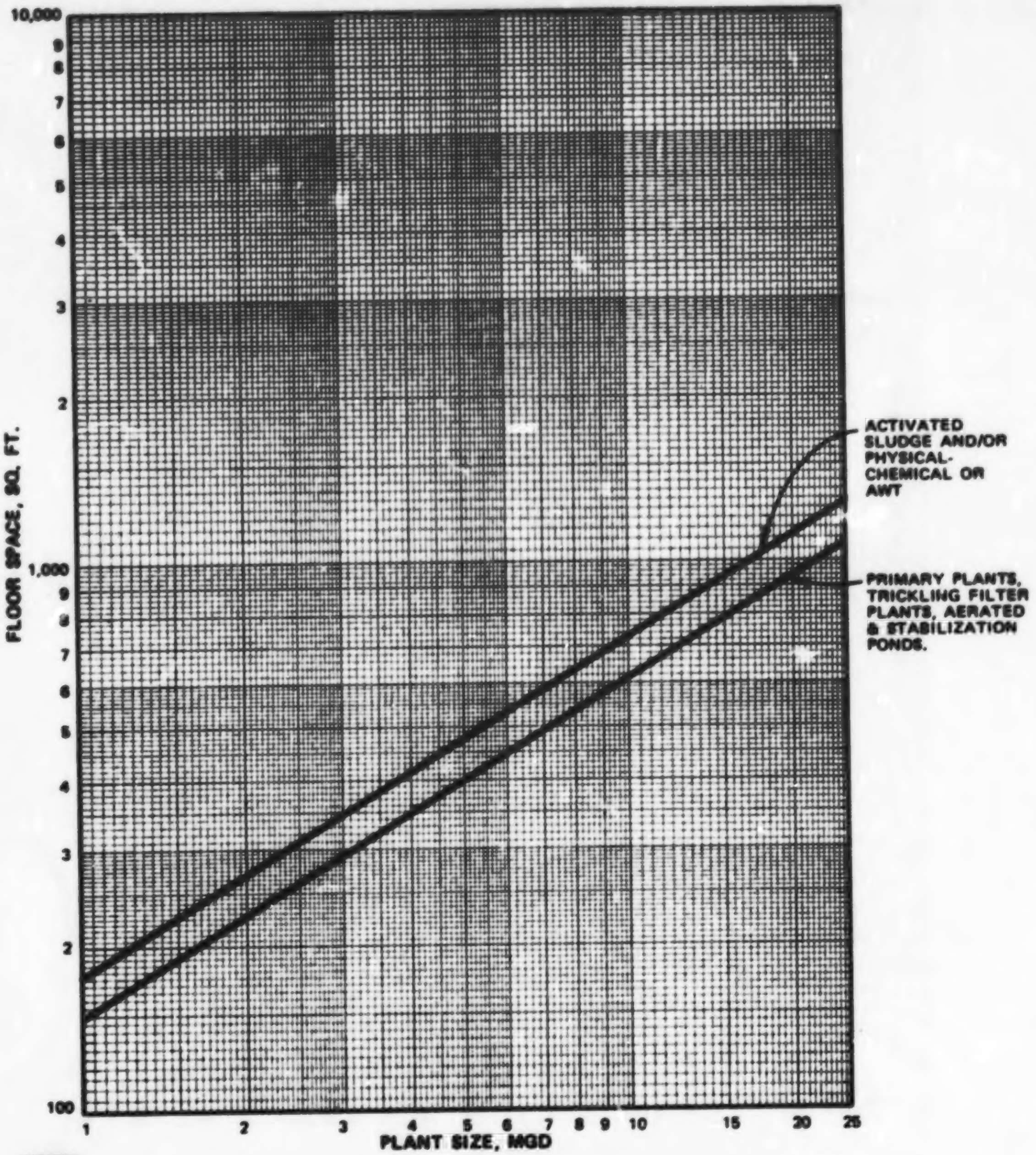
2. Determine chemical requirements, for each test, from this table.

3. The amount of each chemical suggested for each individual test is indicated in parenthesis after each chemical. An exception is the Standard Stock Reagents listed at the top of the table. These reagents are those which are a common requirement for all laboratories. They are strong solutions of the indicated chemical, and, by dilution, are used for making more dilute solutions of the chemical. These, in turn, are used in conducting the various tests.

4. Sum up the amount of each individual chemical required, considering all the suggested tests to be run. Add in the amount of chemical required to make the Standard Stock Reagents, only once, at the beginning of the determination. When the Stock Reagents are required for the individual tests, this is so indicated, and no chemical quantity is shown. The quantity required is already included in the quantity of chemical for the Standard Stock Reagent. In summing up, be sure to add like quantities, i.e., grams and grams, milligrams and milligrams, milliliters and milliliters. 1,000 mg = 1 gm, 1,000 ml = 1 L, 453.6 gms = 1 lb, 3.785L = 1 quart.

5. Multiply the amounts from Step 4 by 2. This is the total quantity of chemical suggested including backup stock.

## APPENDIX C

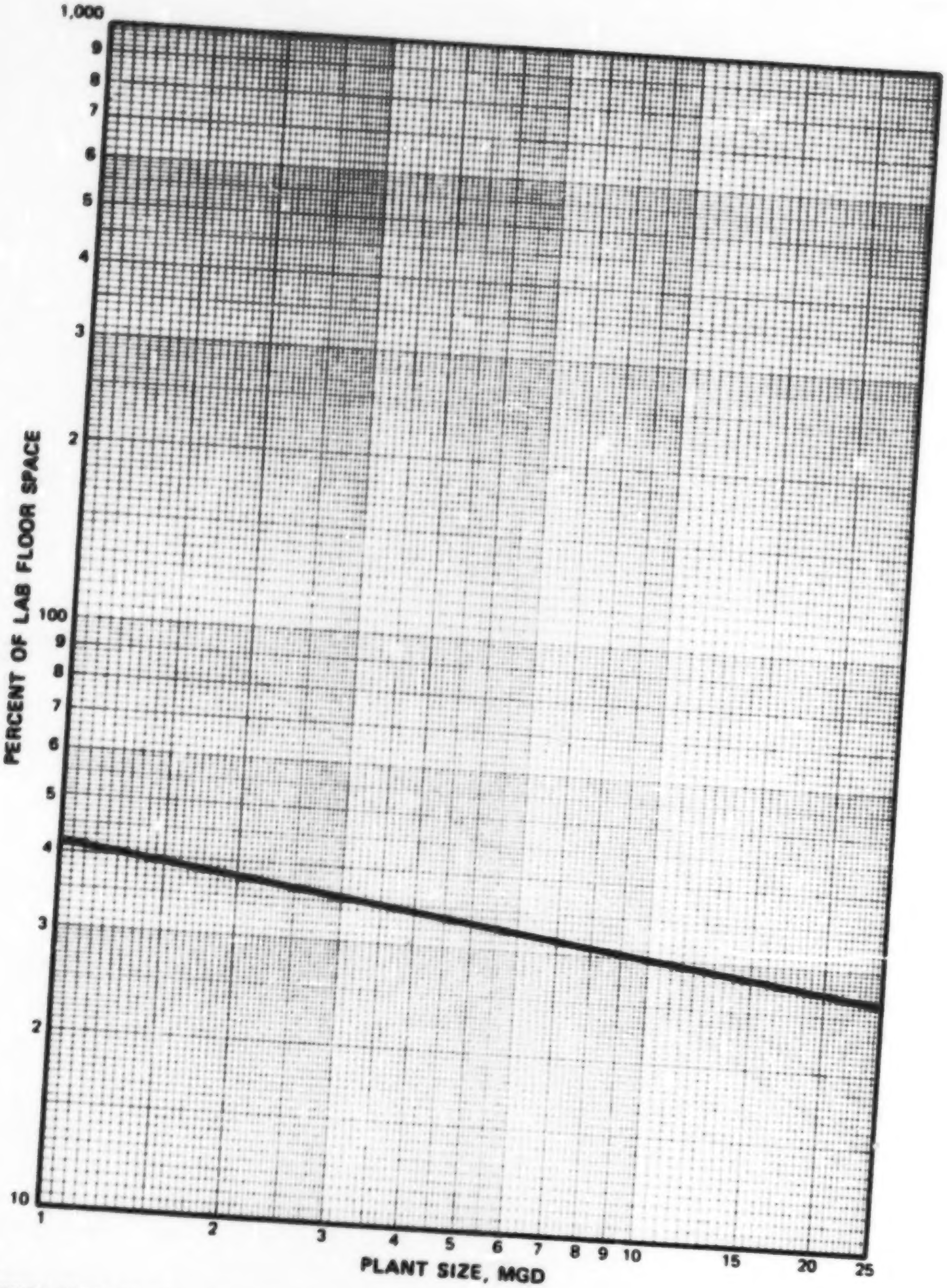


NOTES:

1. MINIMUM FLOOR SPACE REQUIRED FOR PLANTS LESS THAN 1 MGD IS 180 SQ. FT. FOR ACTIVATED SLUDGE, PHYSICAL-CHEMICAL, AND AWT PLANTS, AND 150 SQ. FT. FOR PRIMARY, TRICKLING FILTER, AND POND TYPE PLANTS.
2. INCLUDES SPACE FOR CONDUCTING LABORATORY ADMINISTRATIVE DUTIES.

FIGURE C–1

ESTIMATED LAB FLOOR SPACE

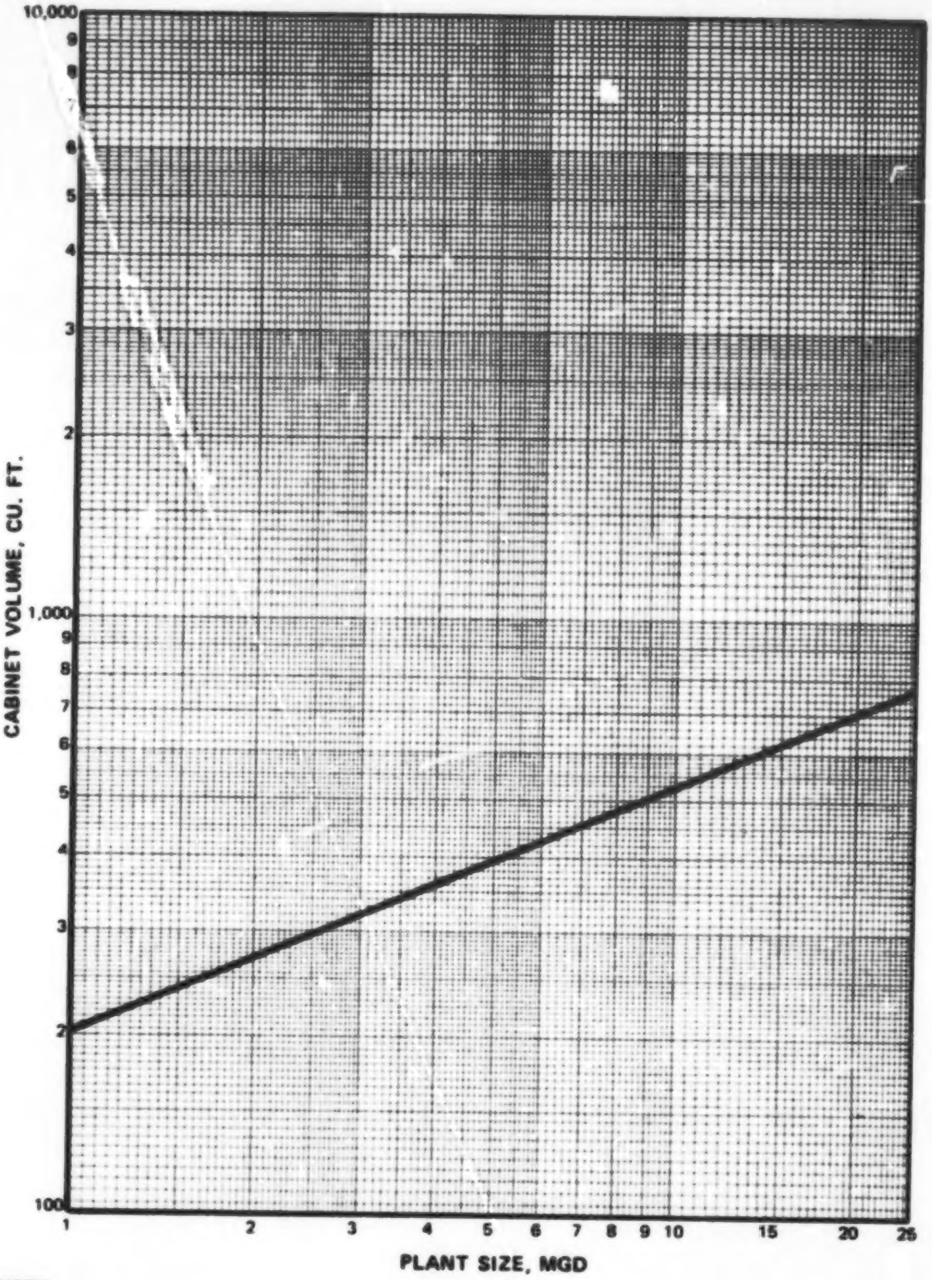


NOTE:

MINIMUM PERCENT OF FLOOR SPACE, REQUIRED FOR BENCH AREA, FOR PLANTS LESS THAN 1 MGD IS 40 PERCENT.

FIGURE C–2

ESTIMATED BENCH AREA



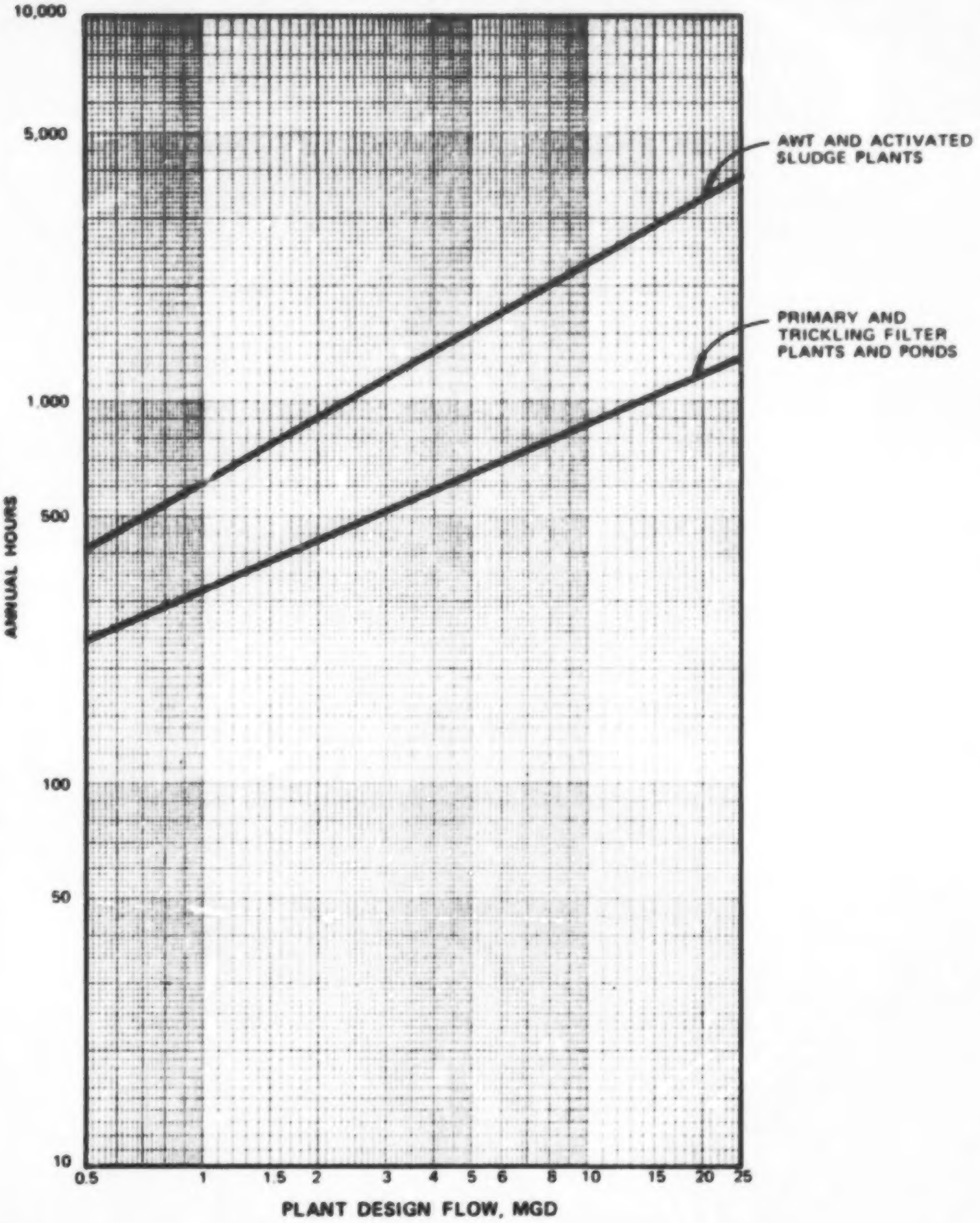
NOTE:

MINIMUM CABINET VOLUME REQUIRED FOR PLANTS LESS THAN 1 MGD IS 200 CU. FT.

FIGURE C–3

ESTIMATED CABINET VOLUME

## APPENDIX D



NOTE:

INCLUDES LAB WORK DONE BY LAB STAFF AS WELL AS OPERATORS.

FIGURE D–1

BASE LABORATORY
MANPOWER ESTIMATE

| FACTOR | ADJUSTMENT | | |
|---|---|---|---|
| LEVEL OF TREATMENT | PRIMARY<br>DECREASE 20% | T/F, PONDS, A/S<br>NO CHANGE | AWT<br>INCREASE 3% PER ADDITIONAL PROCESS |
| INDUSTRIAL WASTES | NONE OR CONSTANT FLOW<br>NO CHANGE | SEASONAL FLOW<br>NO CHANGE | ERRATIC FLOW<br>INCREASE 10% |
| AUTOMATIC SAMPLERS | NONE<br>INCREASE 10% | AT INFLUENT AND EFFLUENT<br>DECREASE 5% | THRU-OUT PLANT<br>DECREASE 2% PER POINT SAMPLED IN ADDITION TO INFLUENT AND EFFLUENT* |
| AUTOMATIC MONITORS AND RECORDING | NONE<br>NO CHANGE | PROVIDED<br>DECREASE 2% PER PARAMETER MONITORED* | |
| OFF PLANT LAB WORK | NONE<br>NO CHANGE | FOR RECEIVING WATER<br>DECREASE 10% | FOR ENTIRE PLANT<br>DECREASE 100% |
| LEVEL OF TRAINING | CERTIFICATION REQUIRED<br>NO CHANGE | CERTIFICATION NOT REQUIRED, QUALIFIED LAB STAFF<br>NO CHANGE | CERTIFICATION NOT REQUIRED UNQUALIFIED LAB STAFF<br>INCREASE 5% |

* MAXIMUM DECREASE EQUALS 20 PERCENT

FIGURE D–2

MANPOWER ESTIMATES – TABLE OF ADJUSTMENT FOR LOCAL CONDITIONS (TALC)

# APPENDIX E

## EXAMPLE A

Plant Size = 0.9 mgd

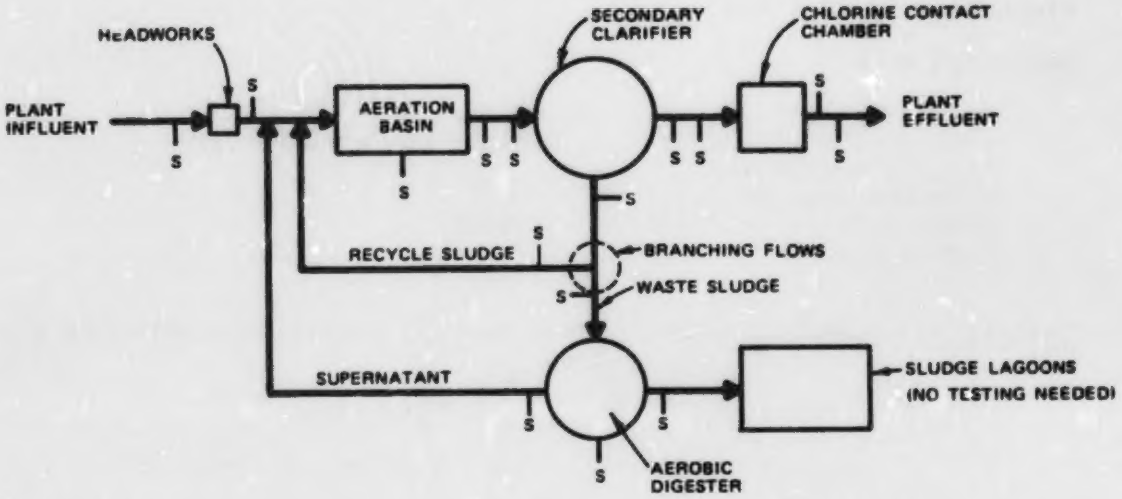
Unit Processes:

Headworks (Comminutor or Grinding)
Activated Sludge (Aeration Basin - Surface Aeration)
Secondary Clarifier
Chlorine Contact Chamber
Aerobic Digester (Surface Aeration)
Sludge Lagoons

Testing Requirements (Sampling and Testing Guidelines, Appendix A):

1. Draw schematic diagram. See next page.
2. Identify sample points from Sampling and Testing Guidelines.
3. Refer to worksheets A,B,C, and D. Write in name of individual unit processes.
4. List minimum and/or optional testing requirements, on worksheets, from Sampling and Testing Guidelines.

   Note: Testing shown includes some optional testing.
5. Eliminate overlaps.
6. List corrected minimum and/or optional testing requirements in column at right of each sheet.

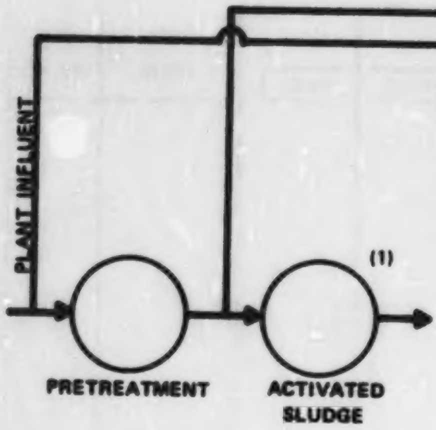

HEADWORKS
SECONDARY CLARIFIER
CHLORINE CONTACT CHAMBER
PLANT INFLUENT
AERATION BASIN
PLANT EFFLUENT
S
RECYCLE SLUDGE
BRANCHING FLOWS
WASTE SLUDGE
SUPERNATANT
SLUDGE LAGOONS (NO TESTING NEEDED)
AEROBIC DIGESTER

SCHEMATIC DIAGRAM

# WORKSHEET A

## OVERALL PERFORMANCE TESTING

**INFLUENT**


PLANT INFLUENT
(1)
PRETREATMENT
ACTIVATED SLUDGE

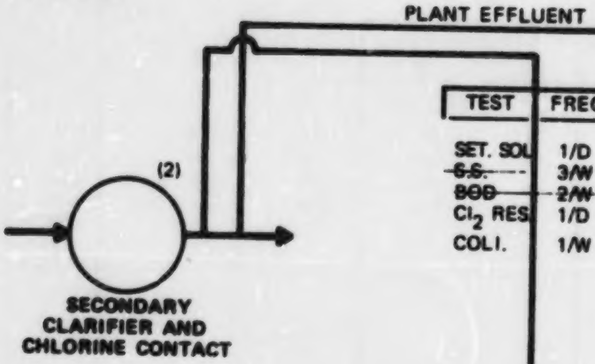
| TEST | FREQ. |
|---|---|
| S.S | 3/W |
| BOD | 2/W |
| pH | 1/D |
| TEMP. | 1/D |
| DO | 3/W |
| FLOW | R |
| ALK. | 2/W |

| TEST | FREQ. |
|---|---|
| ~~BOD~~ | ~~2/W~~ |

| NET TESTS | FRE-QUENCY |
|---|---|
| S.S. | 3/W |
| BOD | 2/W |
| pH | 1/D |
| TEMP. | 1/D |
| DO | 3/W |
| FLOW | R |
| ALK. | 2/W |

(1) INITIAL UNIT PROCESS REGARDLESS OF PRETREATMENT

**EFFLUENT**


PLANT EFFLUENT
(2)
SECONDARY CLARIFIER AND CHLORINE CONTACT

| TEST | FREQ. |
|---|---|
| SET. SOL | 1/D |
| ~~S.S.~~ | 3/W |
| ~~BOD~~ | ~~2/W~~ |
| $Cl_2$ RES | 1/D |
| COLI. | 1/W |

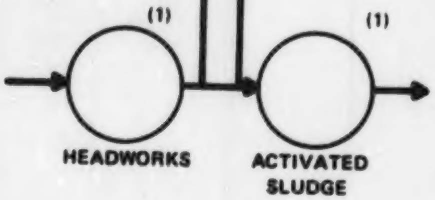
| TEST | FREQ. |
|---|---|
| ALK. | 1/W |
| S.S. | 3/W |
| BOD | 2/W |
| pH | 1/D |
| TEMP. | 1/D |
| DO | 3/W |

| NET TESTS | FRE-QUENCY |
|---|---|
| SET. SOL | 1/D |
| ALK. | 1/W |
| S.S. | 3/W |
| BOD | 2/W |
| $Cl_2$ RES. | 1/D |
| pH | 1/D |
| COLI. | 1/W |
| TEMP. | 1/D |
| DO | 3/W |

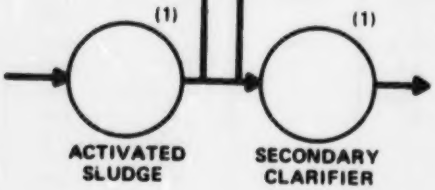
(2) FINAL UNIT PROCESS UNIT PRECEDING DISINFECTION AND INCLUDING DISINFECTION.

# WORKSHEET B

## PROCESS FLOW TESTING


(1)
(1)
HEADWORKS
ACTIVATED SLUDGE

| TEST | FREQ. | TEST | FREQ. | NET TESTS | FREQUENCY |
|---|---|---|---|---|---|
| NO TESTS | | CONSIDERED IN WORK SHEET A | | | |

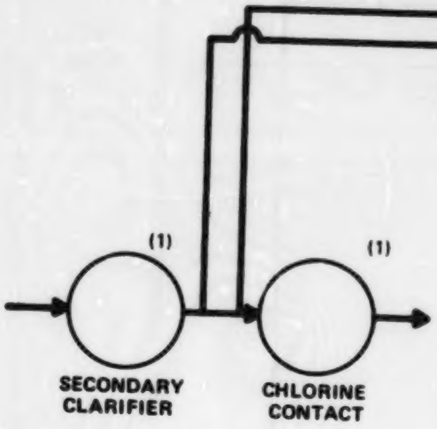

(1)
(1)
ACTIVATED SLUDGE
SECONDARY CLARIFIER

| TEST | FREQ. | TEST | FREQ. | NET TESTS | FREQUENCY |
|---|---|---|---|---|---|
| S.S. | 5/W | pH | 1/D | S.S. | 5/W |
| SET'B'TY. | 5/W | SET. SOL | 1/D | pH | 1/D |
| | | ALK. | 1/M | SET'B'TY. | 5/W |
| | | ~~S.S.~~ | ~~3/W~~ | SET. SOL | 1/D |
| | | | | ALK. | 1/M |

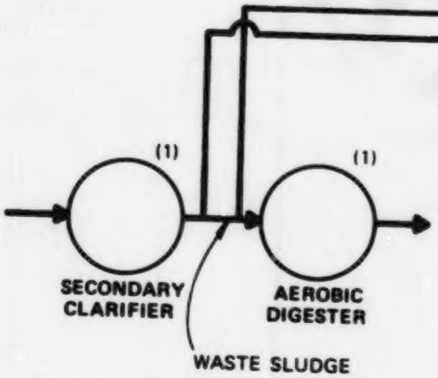
(1) SUCCESSIVE UNIT PROCESSES

# WORKSHEET B

## PROCESS FLOW TESTING


(1)
(1)
SECONDARY CLARIFIER
CHLORINE CONTACT

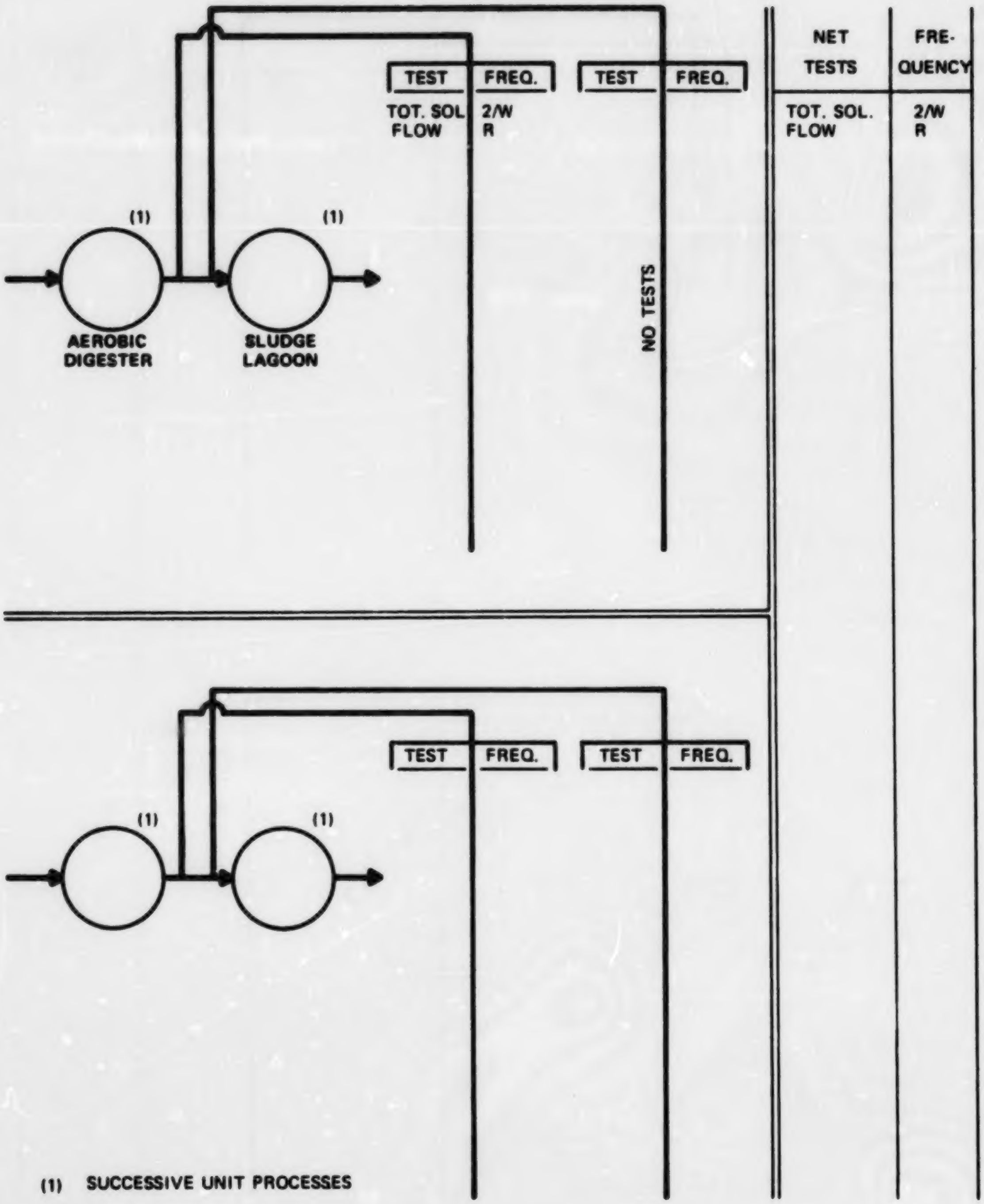
| TEST | FREQ. | TEST | FREQ. | NET TESTS | FRE-QUENCY |
|---|---|---|---|---|---|
| CONSIDERED IN WORK SHEET A | | | | | |


(1)
(1)
SECONDARY CLARIFIER
AEROBIC DIGESTER
WASTE SLUDGE

| TEST | FREQ. | TEST | FREQ. | NET TESTS | FRE-QUENCY |
|---|---|---|---|---|---|
| TOT. SOL<br>FLOW | 3/W<br>R | TOT. SOL | 2/W | TOT. SOL<br>FLOW | 3/W<br>R |

(1) SUCCESSIVE UNIT PROCESSES

# WORKSHEET B
## PROCESS FLOW TESTING


(1)
(1)
AEROBIC DIGESTER
SLUDGE LAGOON
TEST
FREQ.
TOT. SOL
FLOW
2/W
R
TEST
FREQ.
NO TESTS
(1)
(1)
TEST
FREQ.
TEST
FREQ.

| NET TESTS | FRE-QUENCY |
|---|---|
| TOT. SOL. | 2/W |
| FLOW | R |

(1) SUCCESSIVE UNIT PROCESSES

# WORKSHEET C

## PROCESS TESTING

AERATION
BASIN

| TEST | FREQ. |
|---|---|
| DO | 5/W |
| pH | 5/W |
| MICRO-ANAL | 1/W |
| $NO_3$-N | 1/W |

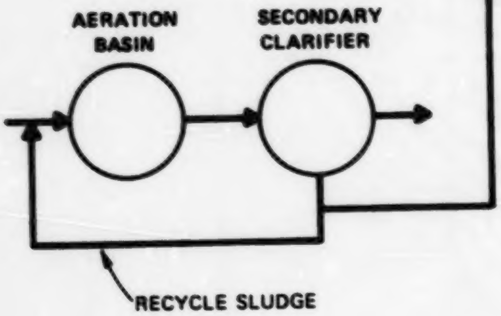
AEROBIC
DIGESTER

| TEST | FREQ. |
|---|---|
| DO | 3/W |
| pH | 1/D |
| TEMP. | 1/D |
| SET. SOL | 3/W |

| NET TESTS | FRE-QUENCY |
|---|---|
| DO | 5/W |
| pH | 5/W |
| MICRO-ANAL | 1/W |
| $NO_3$-N | 1/W |
| DO | 3/W |
| pH | 1/D |
| TEMP. | 1/D |
| SET. SOL. | 3/W |

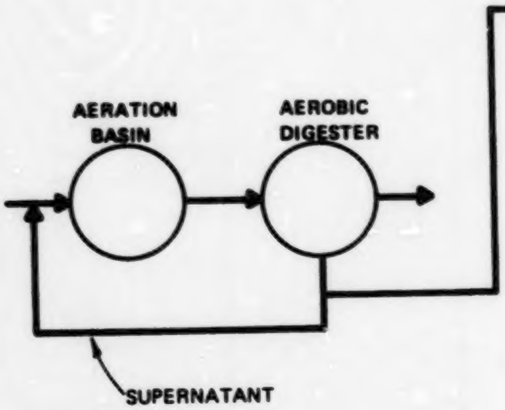
# WORKSHEET D

## RECYCLE FLOW TESTING


AERATION BASIN
SECONDARY CLARIFIER
RECYCLE SLUDGE

| TEST | FREQ. |
|---|---|
| FLOW | R |

NO OTHER TESTS – ALREADY TESTED; WORKSHEET B, SECONDARY CLARIFIER TO AEROBIC DIGESTER


AERATION BASIN
AEROBIC DIGESTER
SUPERNATANT

| TEST | FREQ. |
|---|---|
| pH<br>BOD<br>S.S. | AT SUPERNATANT DRAW OFF |

| NET TEST | FREQUENCY |
|---|---|
| FLOW | R |
| pH<br>BOD<br>S.S. | |

**Equipment Requirements** (Appendix B):

1. Major Equipment Items (Table B-1):

   General Lab Use Items:

   Balance (At minimum level)

   Analytical Weight Class S-1

   Eye Wash
   Hot Plate
   Magnetic Stirrer (at optimum level)
   pH Meter
   Refrigerator
   Safety Shower
   Sterilizer
   Still
   File Cabinet 2 drawer, metal
   Book Case 2 shelf, 30" L x 12" D
   Lab Stool

   Items required for Testing:

   Incubator microbiological
   Incubator BOD
   Microscope
   Oven
   Oxygen Gas Analyzer (at optimum level)
   Pump vacuum-pressure

2. Miscellaneous Equipment:

   As listed in Table B-2.

3. Expendable Items:

   As listed in Table B-3.

4. Glass and Plasticware:

   As listed in Table B-4.

5. Test Kits:

   As listed in Table B-5.

### Chemical Requirements (Table B-6):

| Chemical | Sub-Total from B Table B-6 | Total Amount 2 X Sub-Total |
|---|---|---|
| Sodium Hydroxide, Pellets | 1125 gm | 2250 gm |
| Sulfuric Acid, Conc. | 440 ml | 880 gm |
| Hydrochloric Acid, Conc. | 500 ml | 1000 gm |
| Sodium Carbonate | 2 gm | 4 gm |
| Manganous Sulfate | 480 gm | 960 gm |
| Potassium Iodide | 152 gm | 304 gm |
| Sodium Anide | 10 gm | 20 gm |
| Sodium Thiosulfate | 187 gm | 374 gm |
| Potassium Biniodate | 5 gm | 10 gm |
| Potato Starch | 10 gm | 20 gm |
| Chloroform | 5 ml | 10 gm |
| Potassium Dihydrogen Phosphate | 9 gm | 18 gm |
| Dipotassium Hydrogen Phosphate | 22 gm | 44 gm |
| Ammonium Chloride | 2 gm | 4 gm |
| Magnesium Sulfate | 23 gm | 46 gm |
| Calcium Chloride | 28 gm | 56 gm |
| Ferric Chloride | 1 gm | 2 gm |
| Sodium Sulfite | 2 gm | 4 gm |
| Sulfannic Acid | 32 gm | 64 gm |
| Copper Sulfate | 50 gm | 100 gm |
| Ascetic Acid, Conc. | 500 ml | 1000 ml |

### Space Requirements (Appendix C):

| | |
|---|---|
| Floor Space | (Figure C-1): 180 $ft^2$ |
| Bench Area | (Figure C-2): 0.40(180) = 72 $ft^2$ |
| Cabinet Volume | (Figure C-3): 200 $ft^3$ |

**Staffing Requirements** (Appendix D):

The following conditions hold for this plant:

| | |
|---|---|
| Effluent Requirements; | % removal |
| Industrial Waste; | Seasonal flow |
| Automatic Samplers; | influent and effluent only |

No automatic monitors or recording. Off plant lab work for receiving water.

Person to do lab testing is not certified and has no previous experience.

Base annual lab man-hours (Figure D-1): 560 hours

Corrections from TALC (Figure D-2):

| Factor | | Adjustment | |
|---|---|---|---|
| Degree of Treatment | | 0 | |
| Effluent Requirements | | 0 | |
| Industrial Wastes | | 0 | |
| Automatic Samplers | -5% | | |
| Automatic Monitors and Recorders | | 0 | |
| Off Plant Lab Work | -10% | | |
| Level of Training | | | +5% |
| Total | -15% | | +5% |

Net Change = -15% +5% = -10%

Decrease base annual lab man-hours by 20%; 10% from above, plus 10% for lab work done by operators

Net annual lab man-hours = 560 - 20% (560)

= 560 - 112 = 448 hours

Number lab personnel $= \frac{448}{1500}$ = 0.3 men

In this instance a part-time lab person may be hired, or the lab work may be delegated to the plant operational personnel.

## EXAMPLE B

Plant Size = 23 mgd

Unit Processes:

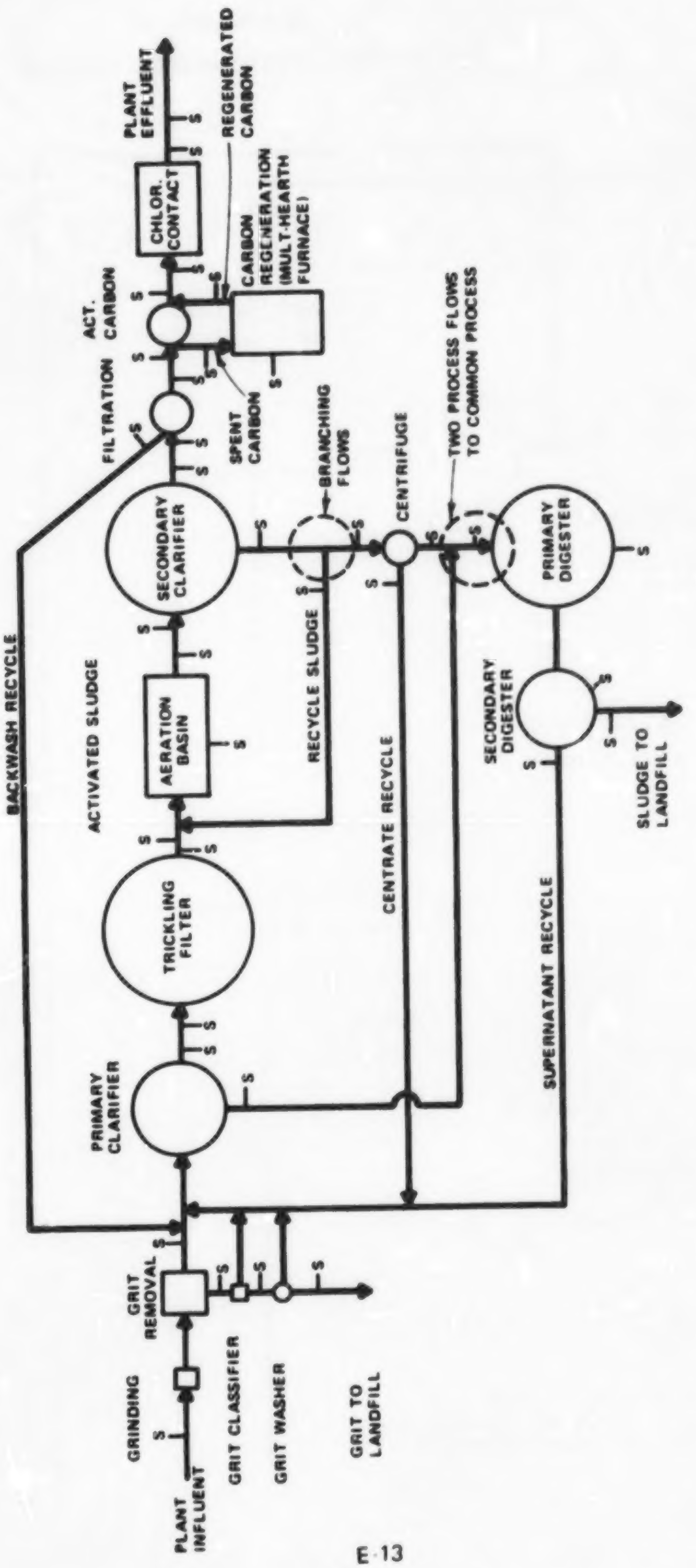
- Headworks
  - Grinding
  - Grit Removal (Aerated)
  - Grit Washing
  - Grit Classifier
- Primary Clarification
- Trickling Filter
- Activated Sludge (Diffused Air)
- Secondary Clarifier
- Filtration
- Activated Carbon
  - Carbon Regeneration
- Chlorination

- Centrifuge
- Anaerobic Digestion

Testing Requirements (Sampling and Testing Guidelines, Appendix A):

1. Draw plant schematic diagram. See next page.
2. Identify sample points from Guidelines.
3. Refer to Worksheets A,B,C, and D. Write in names of individual unit processes.
4. List minimum and/or optional testing requirements on worksheets, from guidelines.

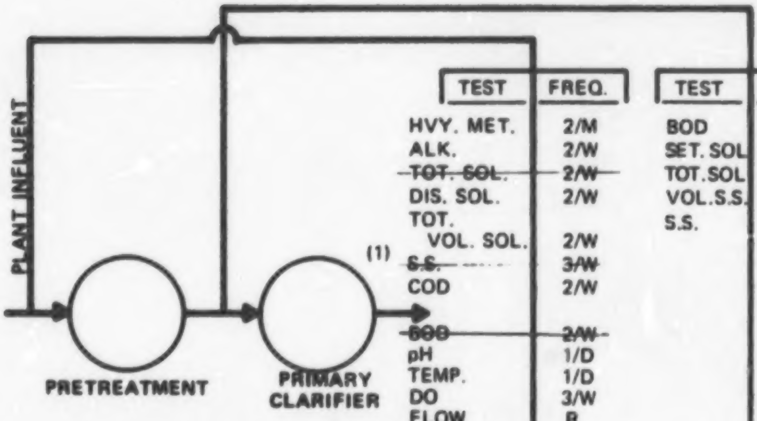
   Note: Test shown includes some optional testing.
5. Eliminate overlaps.
6. List corrected minimum and/or optional testing requirements in column at right of each page.


PLANT INFLUENT
GRINDING
GRIT REMOVAL
GRIT CLASSIFIER
GRIT WASHER
GRIT TO LANDFILL
BACKWASH RECYCLE
PRIMARY CLARIFIER
TRICKLING FILTER
ACTIVATED SLUDGE
AERATION BASIN
SECONDARY CLARIFIER
RECYCLE SLUDGE
CENTRATE RECYCLE
SUPERNATANT RECYCLE
BRANCHING FLOWS
CENTRIFUGE
TWO PROCESS FLOWS TO COMMON PROCESS
PRIMARY DIGESTER
SECONDARY DIGESTER
SLUDGE TO LANDFILL
FILTRATION
ACT. CARBON
SPENT CARBON
CARBON REGENERATION (MULT-HEARTH FURNACE)
REGENERATED CARBON
CHLOR. CONTACT
PLANT EFFLUENT
S

# WORKSHEET A

## OVERALL PERFORMANCE TESTING

**INFLUENT**


PLANT INFLUENT
(1)
PRETREATMENT
PRIMARY CLARIFIER

| TEST | FREQ. |
|---|---|
| HVY. MET. | 2/M |
| ALK. | 2/W |
| ~~TOT. SOL.~~ | ~~2/W~~ |
| DIS. SOL. | 2/W |
| TOT. VOL. SOL. | 2/W |
| ~~S.S.~~ | ~~3/W~~ |
| COD | 2/W |
| ~~BOD~~ | ~~2/W~~ |
| pH | 1/D |
| TEMP. | 1/D |
| DO | 3/W |
| FLOW | R |

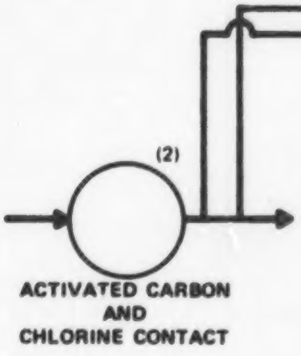
| TEST | FREQ. |
|---|---|
| BOD | 2/W |
| SET. SOL | 3/W |
| TOT. SOL | 3/W |
| VOL. S.S. | 3/W |
| S.S. | 3/W |

| NET TESTS | FRE-QUENCY |
|---|---|
| HVY. MET. | 2/M |
| ALK. | 2/W |
| DIS. SOL. | 2/W |
| COD | 2/W |
| pH | 1/D |
| TEMP. | 1/D |
| BOD | 2/W |
| SET. SOL. | 3/W |
| TOT. SOL. | 3/W |
| VOL. S.S. | 3/W |
| S.S. | 3/W |
| DO | 3/W |
| FLOW | R |
| TOT. VOL S. | 2/W |

(1) INITIAL UNIT PROCESS REGARDLESS OF PRETREATMENT

**EFFLUENT**

PLANT EFFLUENT


(2)
ACTIVATED CARBON
AND
CHLORINE CONTACT

| TEST | FREQ. |
|---|---|
| COD | 3/W |
| MBAS | 1/D |
| F. COLI. | 1/W |
| COLI. | 1/W |
| $Cl_2$ RES. | R |
| pH | Mn |

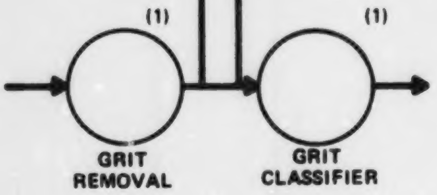
| TEST | FREQ. |
|---|---|
| HVY. MET. | 2/M |
| ALK. | 2/W |
| TOT. SOL | 2/W |
| DIS. SOL | 2/W |
| TOT. VOL. S. | 2/W |
| S.S. | 3/W |
| ~~COD~~ | 2/W |
| BOD | 2/W |
| pH | 1/D |
| TEMP. | 1/D |
| TURB. | R |
| DO | 3/W |

| NET TESTS | FRE-QUENCY |
|---|---|
| COD | 3/W |
| MBAS | 1/D |
| F. COLI. | 1/W |
| COLI. | 1/W |
| $Cl_2$ REL. | R |
| HVY. MET. | 2/M |
| ALK. | 2/W |
| TOT. SOL. | 2/W |
| TOT. VOL. S. | 2/W |
| S.S. | 3/W |
| BOD | 2/W |
| pH | Mn |
| TEMP. | 1/D |
| TURB. | R |
| DO | 3/W |

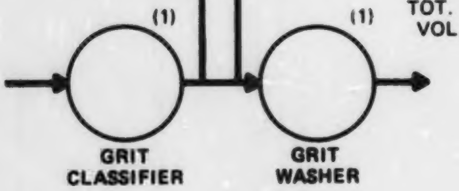
(2) FINAL UNIT PROCESS UNIT PRECEDING DISINFECTION AND INCLUDING DISINFECTION.

## WORKSHEET B

## PROCESS FLOW TESTING


(1)
(1)
GRIT REMOVAL
GRIT CLASSIFIER

| TEST | FREQ. | TEST | FREQ. | NET TESTS | FRE- QUENCY |
|---|---|---|---|---|---|
| TOT. SOL | 2/W | NO TESTS | | TOT. SOL | 2/W |
| TOT. VOL. SOL | 2/W | | | TOT. VOL. SOL | 2/W |

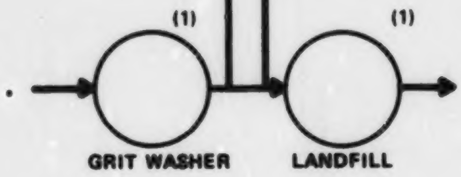

(1)
(1)
GRIT CLASSIFIER
GRIT WASHER

| TEST | FREQ. | TEST | FREQ. | NET TESTS | FRE- QUENCY |
|---|---|---|---|---|---|
| TOT. SOL | 2/W | NO TESTS | | TOT. SOL | 2/W |
| TOT. VOL. SOL | 2/W | | | TOT. VOL. SOL | 2/W |

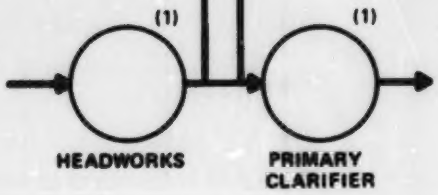
(1) SUCCESSIVE UNIT PROCESSES

## WORKSHEET B

## PROCESS FLOW TESTING


(1)
(1)
GRIT WASHER
LANDFILL

| TEST | FREQ. | TEST | FREQ. | NET TESTS | FRE-QUENCY |
|---|---|---|---|---|---|
| TOT. SOL | 2/W | NO TESTS | | TOT. SOL | 2/W |
| TOT. VOL. SOL | 2/W | | | TOT. VOL. SOL | 2/W |

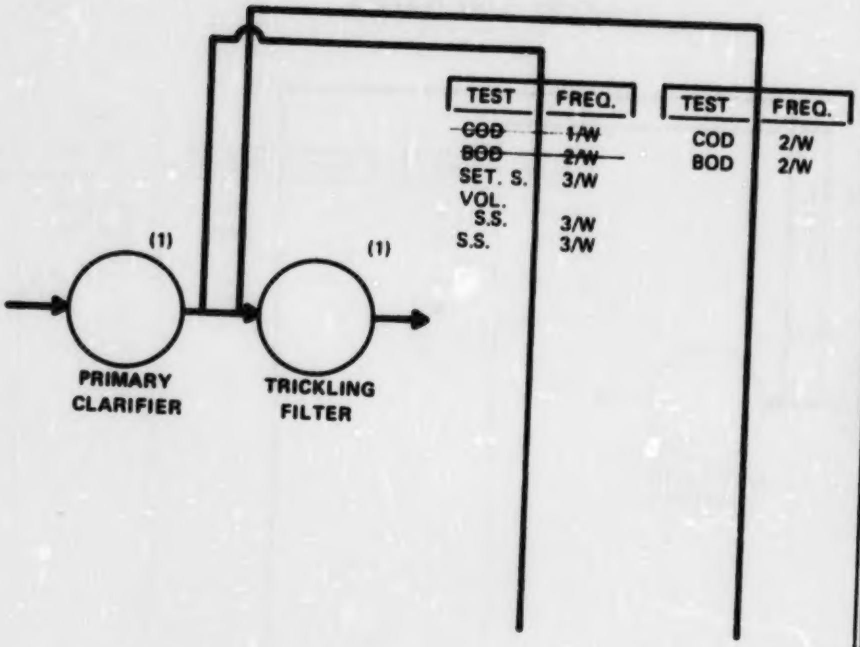

(1)
(1)
HEADWORKS
PRIMARY CLARIFIER

| TEST | FREQ. | TEST | FREQ. |
|---|---|---|---|
| NO TESTS | | CONSIDERED ON WORK SHEET A | |

(1) SUCCESSIVE UNIT PROCESSES

# WORKSHEET B

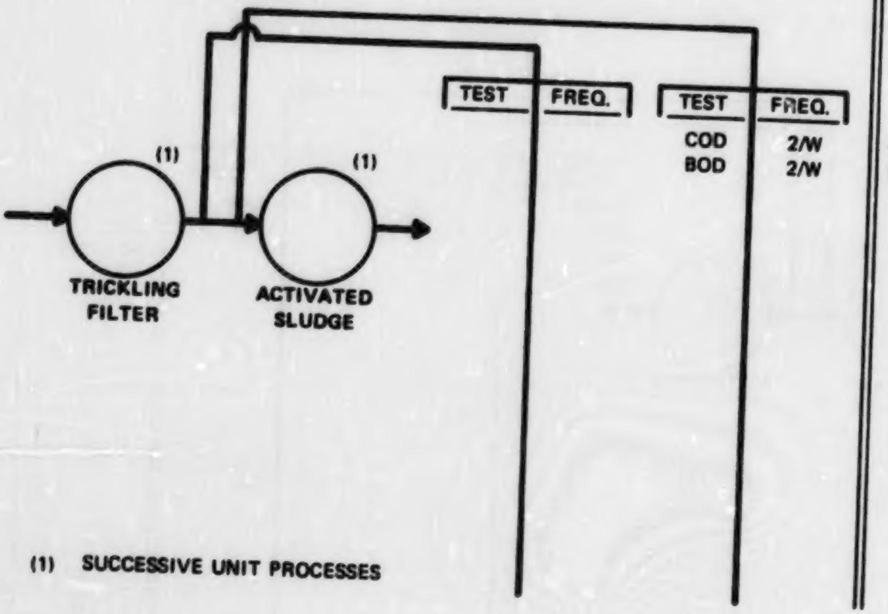
## PROCESS FLOW TESTING


(1)
(1)
PRIMARY CLARIFIER
TRICKLING FILTER

| TEST | FREQ. |
|---|---|
| ~~COD~~ | ~~1/W~~ |
| ~~BOD~~ | ~~2/W~~ |
| SET. S. | 3/W |
| VOL. S.S. | 3/W |
| S.S. | 3/W |

| TEST | FREQ. |
|---|---|
| COD | 2/W |
| BOD | 2/W |

| NET TESTS | FRE-QUENCY |
|---|---|
| SET. S. | 3/W |
| VOL. S.S. | 3/W |
| S.S. | 3/W |
| COD | 2/W |
| BOD | 2/W |


(1)
(1)
TRICKLING FILTER
ACTIVATED SLUDGE

| TEST | FREQ. |
|---|---|
|  |  |

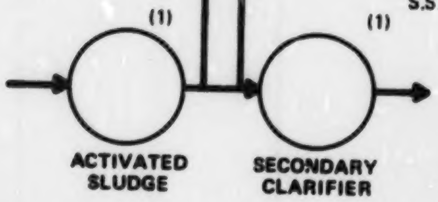
| TEST | FREQ. |
|---|---|
| COD | 2/W |
| BOD | 2/W |

| NET TESTS | FRE-QUENCY |
|---|---|
| COD | 2/W |
| BOD | 2/W |

(1) SUCCESSIVE UNIT PROCESSES

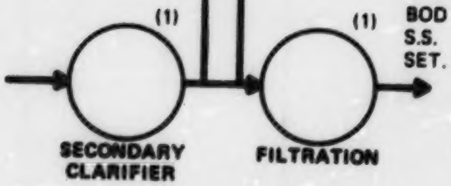
## WORKSHEET B

## PROCESS FLOW TESTING


(1)
(1)
ACTIVATED SLUDGE
SECONDARY CLARIFIER

| TEST | FREQ. | TEST | FREQ. |
|---|---|---|---|
| SET'B'TY. | 5/W | ~~S.S.~~ | ~~3/W~~ |
| TOT. SOL. | 3/W | ALK. | 1/W |
| TOT. VOL. SOL | 3/W | SET. SOL | 1/D |
| S.S. | 5/W | pH | 1/D |

| NET TESTS | FRE-QUENCY |
|---|---|
| SET'B'TY. | 5/W |
| TOT. SOL | 3/W |
| TOT. VOL. SOL | 3/W |
| S.S. | 5/W |
| ALK. | 1/W |
| SET. SOL. | 1/D |
| pH | 1/D |


(1)
(1)
SECONDARY CLARIFIER
FILTRATION

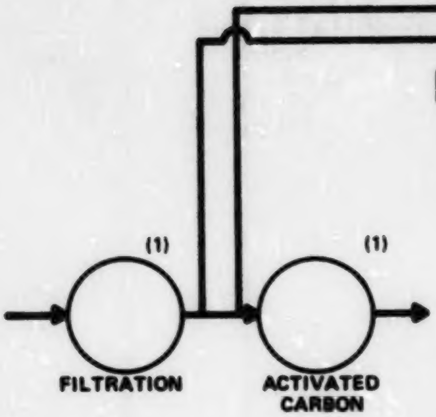
| TEST | FREQ. | TEST | FREQ. |
|---|---|---|---|
| TURB. | R | ~~S.S.~~ | ~~2/W~~ |
| BOD | 2/W | | |
| S.S. | 3/W | | |
| SET. SOL. | 1/D | | |

| NET TESTS | FRE-QUENCY |
|---|---|
| TURB. | R |
| BOD | 2/W |
| SET. SOL | 1/D |
| S.S. | 3/W |

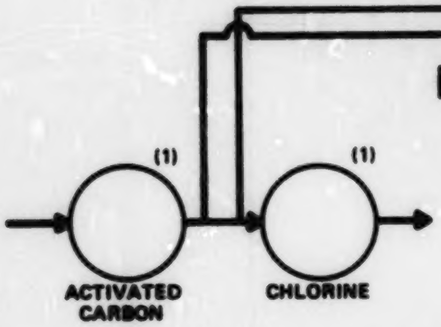
(1) SUCCESSIVE UNIT PROCESSES

# WORKSHEET B

## PROCESS FLOW TESTING


(1)
(1)
FILTRATION
ACTIVATED CARBON

| TEST | FREQ. | TEST | FREQ. | NET TESTS | FRE-QUENCY |
|---|---|---|---|---|---|
| TURB. | R | COD | 3/W | TURB. | R |
| BOD | 2/W | pH | Mn | BOD | 2/W |
| S.S. | 2/W | MBAS | 1/D | S.S. | 2/W |
| | | | | COD | 3/W |
| | | | | pH | Mn |
| | | | | MBAS | 1/D |

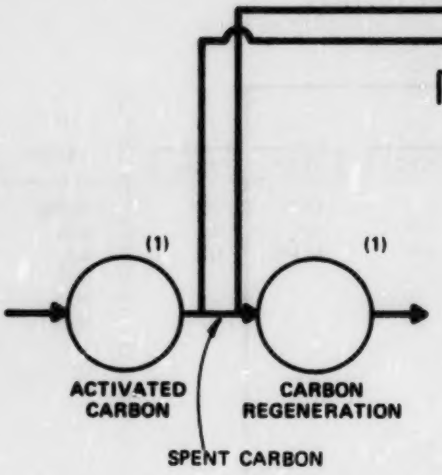

(1)
(1)
ACTIVATED CARBON
CHLORINE

| TEST | FREQ. | TEST | FREQ. | NET TESTS | FRE-QUENCY |
|---|---|---|---|---|---|
| CONSIDERED ON WORK SHEET A | | pH | 1/D | pH | 1/D |
| | | TEMP. | 1/D | TEMP. | 1/D |

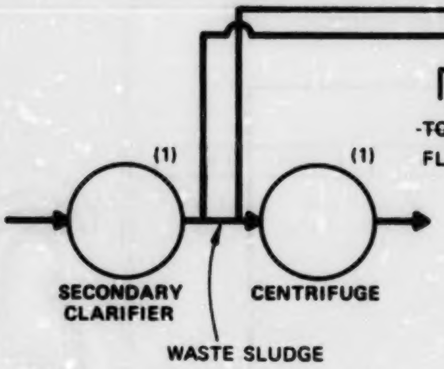
(1) SUCCESSIVE UNIT PROCESSES

## WORKSHEET B

## PROCESS FLOW TESTING


(1)
(1)
ACTIVATED CARBON
CARBON REGENERATION
SPENT CARBON

| TEST | FREQ. | TEST | FREQ. | NET TESTS | FREQUENCY |
|---|---|---|---|---|---|
| NO TESTS | | IODINE NO. | 1/D | IODINE NO. | 1/D |
| | | APP. DEN. | 1/D | APP. DEN. | 1/D |

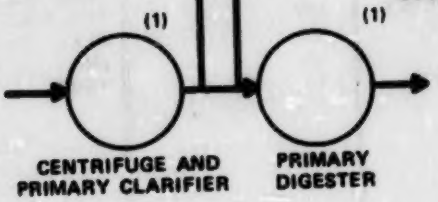

(1)
(1)
SECONDARY CLARIFIER
CENTRIFUGE
WASTE SLUDGE

| TEST | FREQ. | TEST | FREQ. | NET TESTS | FREQUENCY |
|---|---|---|---|---|---|
| ~~TOT. SOL.~~ | ~~3/W~~ | TOT. SOL | 1/D | TOT. SOL. | 1/D |
| FLOW | R | | | FLOW | R |

(1) SUCCESSIVE UNIT PROCESSES

## WORKSHEET B

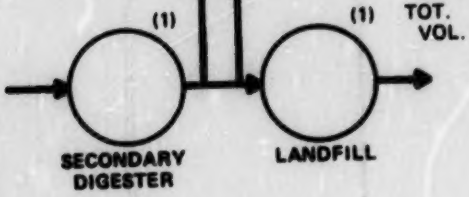
## PROCESS FLOW TESTING


(1)
(1)
CENTRIFUGE AND PRIMARY CLARIFIER
PRIMARY DIGESTER

| TEST | FREQ. |
|---|---|
| TOT. SOL | 1/D |
| CENTFGD. SLUDGE TOTAL SOLIDS | 3/D |

| TEST | FREQ. |
|---|---|
| GREASE | 1/M |
| TOT. VOL. SOL | 2/W |

| NET TESTS | FRE-QUENCY |
|---|---|
| TOT. SOL | 1/D |
| GREASE | 1/M |
| TOT. VOL. SOL | 2/W |
| CENTFGD. SLUDGE TOTAL SOLIDS | 3/D |


(1)
(1)
SECONDARY DIGESTER
LANDFILL

| TEST | FREQ. |
|---|---|
| TOT. SOL<br>TOT. VOL. SOL | WHEN SLUDGE IS DRAWN OFF |

| TEST | FREQ. |
|---|---|
| NO TESTS | |

| NET TESTS | FRE-QUENCY |
|---|---|
| TOT. SOL<br>TOT. VOL.SOL. | WHEN SLUDGE IS DRAWN OFF |

(1) SUCCESSIVE UNIT PROCESSES

# WORKSHEET C
## PROCESS TESTING

PRIMARY
DIGESTER

| TEST | FREQ. |
|---|---|
| GAS | 1/W |
| GREASE | 1/M |
| V.A. | 3/W |
| TOT. VOL. SOL | 1/W |
| TOT. SOL | 1/W |
| ALK. | 1/D |
| pH | 1/D |
| TEMP. | Mn |

SECONDARY
DIGESTER

| TEST | FREQ. |
|---|---|
| pH | Mn |

| NET TESTS | FREQUENCY |
|---|---|
| GAS | 1/W |
| GREASE | 1/M |
| V.A. | 3/W |
| TOT. VOL. SOL. | 1/W |
| TOT. SOL | 1/W |
| ALK. | 1/D |
| pH | 1/D |
| TEMP. | Mn |
| pH | Mn |

# WORKSHEET C
## PROCESS TESTING

ACTIVATED SLUDGE

| TEST | FREQ. |
|---|---|
| MICRO-ANAL | 2/W |
| $NO_3$-N | 3/W |
| DO | 5/W |
| pH | 5/W |
| AIR INPUT | R |

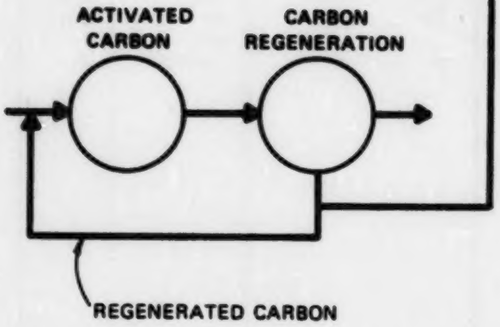
CARBON REGENERATION

| TEST | FREQ. |
|---|---|
| TEMP. | Mn @ EA. HEARTH |
| $O_2$ | 1/D |

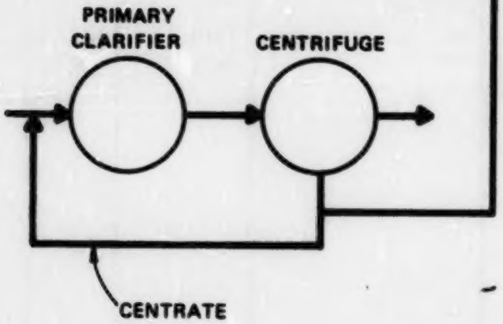
| NET TESTS | FRE-QUENCY |
|---|---|
| MICRO | 2/W |
| $NO_3$-N | 3/W |
| DO | 5/W |
| pH | 5/W |
| AIR INPUT | R |
| TEMP. | Mn |
| $O_2$ | 1/D |

# WORKSHEET D

## RECYCLE FLOW TESTING


ACTIVATED CARBON
CARBON REGENERATION
REGENERATED CARBON

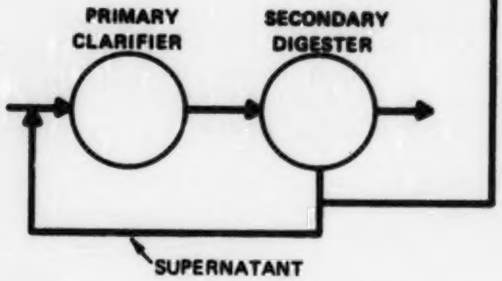
| TEST | FREQ. | NET TEST | FRE-QUENCY |
|---|---|---|---|
| IODINE NO. | 1/D | IODINE NO. | 1/D |
| % ASH | 1/D | % ASH | 1/D |
| APP. DEN. | 1/H | APP. DEN. | 1/H |


PRIMARY CLARIFIER
CENTRIFUGE
CENTRATE

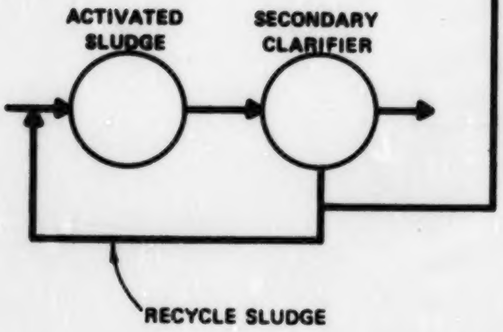
| TEST | FREQ. | NET TEST | FRE-QUENCY |
|---|---|---|---|
| BOD | 1/W | BOD | 1/W |
| S.S. | 1/D | S.S. | 1/D |
| SET. SOL | 1/H | SET. SOL | 1/H |
| FLOW | R | FLOW | R |

## WORKSHEET D

## RECYCLE FLOW TESTING


PRIMARY CLARIFIER
SECONDARY DIGESTER
SUPERNATANT

| TEST | FREQ. | NET TEST | FRE-QUENCY |
|---|---|---|---|
| BOD | 1/W | BOD | 1/W |
| S.S. | 1/W | S.S. | 1/W |
| FLOW | R | FLOW | R |


ACTIVATED SLUDGE
SECONDARY CLARIFIER
RECYCLE SLUDGE

| TEST | FREQ. | | |
|---|---|---|---|
| FLOW | R | FLOW | R |

Equipment Requirements (Appendix B):

1. Major Equipment (Table B-1):

General Lab Use Items:

- Balance (at optimum level)
  - Analytical balance
  - Top loading balance
  - Moisture determination balance
- Centrifuge (at optimum level)
  - Clinical centrifuge, 6 place 15 ml
  - Polycarbonate tubes, graduated 15 ml
  - International Model MN-S centrifuge
  - Head, 6 place 50 ml
  - Metal Shields, 15 ml
  - Metal Shields, 50 ml
  - Trunnion Carriers, 3 place, 15 ml
  - Trunnion Rings, 50 ml
  - Polycarbonate tubes, graduated 15 ml
  - Borosilicate tubes, conical graduated, 50 ml
- Hot Plate
- Magnetic Stirrer
- pH meter
- Refrigerator
- Eye Fountain - Safety Shower Combination (at optimum level)
- Still, Barnstead Electric, (at optimum level)
- Office Desk
- File Cabinet, 4 drawer, metal
- Book Case, 4 shelf, 30"L X 12"D
- Lab Stools
- Desk Chair, swivel, arm.

Items for Testing:

- Autotransformer, variable
- Chlorine residual analyzer
- Chlorine residual recorder
- Fume Hood
- Gas Analyzer
- Heating Mantles

  - 250 ml
  - 500 ml
- Tissue Culture Hood
- Incubator, Microbiological
- Incubator, BOD
- Microscope
- Muffle Furnace
- Muffle Furnace Controller (at optimum level)
- Oven

Items for Testing (Continued)

- Oxygen Gas Analyzer
  - Extension Handle
  - BOD Stirring Probe
  - Non-stirring BOD Probe
  - Field Oxygen Probe, 10 feet
- pH Meter - continuous monitoring, required at 3 locations in plant
  - Pump, Vacuum-pressure
  - Spectrophotometer
  - Curettes, rectangular, glass, 10 mm
  - Sterilizer
  - Sterilizer, UV (at optimum level)
- Thermometer, monitoring, required at 7 locations throughout plant; 1 at digester and 1 at each hearth of multiple hearth furnace with 6 hearths
- Turbidimeter, continuous recording; 3 required
- Water bath
- 5 flow meters and recorders

2. Miscellaneous Equipment:

   As listed in Table B-2.

3. Expendable Items:

   As listed in Table B-3.

4. Glass and Plasticware:

   As listed in Table B-4.

5. Test Kits:

   As listed in Table B-5.

Chemical Requirements (Table B-6):

| Chemical | Sub-Total from B Table B-6 | Total Amount 2 X Sub-Total |
|---|---|---|
| Sodium Hydroxide | 1125 gm | 2250 gm |
| Sulfuric Acid, Conc. | 5470 ml | 10,940 ml |
| Hydrochloric Acid, Conc. | 949 ml | 1898 ml |
| Sodium Carbonate | 3 gm | 6 gm |
| Manganous Sulfate | 480 gm | 960 gm |
| Potassium Iodide | 443 gm | 886 gm |
| Sodium Anide | 11 gm | 22 gm |
| Sodium Thiosulfate | 212 gm | 424 gm |
| Potassium Biniodate | 5 gm | 10 gm |
| Potato Starch | 20 gm | 40 gm |
| Chloroform | 2155 gm | 4210 gm |
| Potassium Dihydrogen Phosphate | 9 gm | 18 gm |
| Dipotassium Hydrogen Phosphate | 22 gm | 44 gm |
| Disodium Hydrogen Phosphate Heptahydrate | 34 gm | 68 gm |
| Ammonium Chloride | 2 gm | 4 gm |
| Magnesium Sulfate | 23 gm | 46 gm |
| Calcium Chloride | 28 gm | 56 gm |
| Ferric Chloride | 1 gm | 2 gm |
| Sodium Sulfide | 12 gm | 24 gm |
| Potassium Dichromate | 14 gm | 28 gm |
| Silver Sulfate | 24 gm | 48 gm |
| Ferrous Ammonium Sulfate | 39 gm | 78 gm |
| 1,10 - Phenanthroline Monohydrate | 2 gm | 4 gm |
| Ferrous Sulfate | 1 gm | 2 gm |
| Mercuric Sulfate | 40 gm | 80 gm |

Chemical Requirements (Continued)

| Chemical | Sub-Total from B Table B-6 | Total Amount 2 X Sub-Total |
|---|---|---|
| Sodium Chloride | 300 gm | 600 gm |
| Brucine Sulfate | 1 gm | 2 gm |
| Sulfanilic Acid | 1 gm | 2 gm |
| Potassium Nitrate | 1 gm | 2 gm |
| Sulfanic Acid | 32 gm | 64 gm |
| Copper Sulfate | 50 gm | 100 gm |
| Ascetic Acid | 850 ml | 1700 gm |
| Silicic Acid | 10 gm | 20 gm |
| n-Butanol | 100 ml | 200 gm |
| Thynol Blue Indicator |  | 1 pt |
| Phenolphthalein Indicator |  | 4510 ml |
| Nitric Acid | 2255 ml | 4510 ml |
| Hydrogen Peroxide | 1000 ml | 2000 ml |
| Perchloric Acid | 2250 ml | 4500 ml |
| Ammonium Acetate | 400 gm | 800 gm |
| Cadmium Metal | 1 gm | 2 gm |
| Potassium Sodium Tartrate | 50 gm | 100 gm |
| Dithozone | 2 gm | 4 gm |
| Carbon Tetrachloride | 2250 ml | 5000 ml |
| Calcium Oxide | 20 gm | 40 gm |
| Diphenylthrocarbozone | 51 gm | 102 gm |
| Ammonium Hydroxide | 1760 ml | 3520 gm |
| Dimethyglyoxime | 1 gm | 2 gm |
| Ethyl Alcohol | 600 ml | 1200 gm |
| Methyl Orange Indicator |  | 1 pt |
| Phosphoric Acid | 401 ml | 802 ml |
| Potassium Permanganate | 6 gm | 12 gm |
| Diphenylcarbazide | 1 gm | 2 gm |
| Acetone | 50 ml | 100 ml |
| Cupferron | 6 gm | 12 gm |

**Chemical Requirements** (Continued)

| **Chemical** | **Sub-Total from B Table B-6** | **Total Amount 2 X Sub-Total** |
|---|---|---|
| Sodium Nitrite | 6 gm | 12 gm |
| Copper Metal | 2 gm | 4 gm |
| Hydroxylamine-Hydrochloride | 110 gm | 220 gm |
| Sodium Citrate | 160 gm | 320 gm |
| 2,9-Dimethyl-1,10-Phenanthroline Humihydrate | 1 gm | 2 gm |
| Methyl Alcohol | 140 ml | 280 ml |
| Congo Red pH Paper | 1 ft | 2 ft |
| Iron | 1 gm | 2 gm |
| Sodium Acetate | 200 gm | 400 gm |
| 1,10 - Phenanthroline | 1 gm | 2 gm |
| Isopropyl Ether | 100 ml | 200 ml |
| Lead Metal | 1 gm | 2 gm |
| Hydrazine | 15 ml | 30 ml |
| Sodium Tartrate | 20 gm | 40 gm |
| Tartaric Acid | 50 gm | 100 gm |
| Sodium Bicarbonate | 10 gm | 20 gm |
| Potassium Cyanide | 15 gm | 30 gm |
| Sodium Oxalate | 10 gm | 20 gm |
| Sodium Bisulfite | 10 gm | 20 gm |
| Silver Nitrate | 5 gm | 10 gm |
| Ammonium Persulfate | 25 gm | 50 gm |
| Nickel Sulfate | 1 gm | 2 gm |
| Bromine | 100 gm | 200 gm |
| 1,2-Cycloheptanedione-dioxime | 1 gm | 2 gm |
| Zinc Metal | 1 gm | 2 gm |
| Methyl Red Indicator | | 1 pt |
| Diethanolamine | 4 gm | 8 gm |

**Chemical Requirements** (Continued)

| **Chemical** | **Sub-Total from B Table B-6** | **Total Amount 2 X Sub-Total** |
|---|---|---|
| Carbon Disulfide | 1 ml | 2 ml |
| Sodium Sulfide | 3 gm | 6 gm |
| Hydrogen Sulfide | 2 lb | 4 lb |
| n-Hexane | 1000 ml | 2000 ml |
| Diatomaceous-Silica Filter Aid | 1000 ml | 2000 ml |
| Iodine | 127 gm | 254 gm |
| Ammonia Solution | 50 ml | 100 ml |
| Standard ABS | 1 gm | 2 gm |
| Methylene Blue | 1 gm | 2 gm |
| Monosodium Dihydrogen Phosphate Monohydrate | 50 gm | 100 gm |

**Space Requirements** (Appendix C):

Floor Space (Figure C-1): 1250 $\text{ft}^2$

Bench Area (Figure C-2): 0.265(1250) = 331.25 $\text{ft}^2$

Cabinet Volume (Figure C-3): 740 $\text{ft}^3$

**Staffing Requirements** (Appendix D):

The following conditions hold for this plant:

| | |
|---|---|
| Effluent Requirements; | Limit on constituents |
| Industrial Waste; | Erratic flow |
| Automatic Samplers; | Throughout Plant at 11 locations in addition to influent and effluent. This was determined from Sampling and Testing Guidelines. |
| Automatic Monitoring and Recording | at 7 locations |
| Off Plant Lab Work | None |
| Level of Training | All personnel certified and with previous experience |

Base annual lab man-hours (Figure D-1): 3800 hours

Corrections from TALC (Figure D-2):

| **Factor** | **Adjustment** | | |
|---|---|---|---|
| Degree of Treatment | | | +6% |
| Effluent Requirements | | | +10% |
| Industrial Wastes | | | +10% |
| Automatic Samplers | -22% | | |
| Automatic Monitoring and Recording | -14% | | |
| Off Plant Lab Work | | 0 | |
| Level of Training | | 0 | |
| Totals | -28% | | +26% |

Net Change = -28% +26% = -2%

Decrease base annual lab man-hours by 12%; 2% from above, plus 10% for work done by operational personnel.

Net annual lab man-hours = 3800 - 12% (3800)
= 3800 - 456
= 3344 hours

Number of Personnel = $\frac{3344}{1500}$ = 2.22 men

In this instance, a lab technician and a chemist might be hired, with the excess work being done by part-time lab technicians or operational personnel.

# APPENDIX F

## TREATMENT PLANTS SURVEYED

Sacramento County - Northwest Plant, California
City of San Leandro, California
City of San Rafael, California
South Tahoe P.U.D., California
City of Medford, Oregon
City of Salem, Oregon
City of Tualatin, Oregon
N. Roseburg Sanitation District, Oregon
City of Durham, North Carolina
City of Lebanon, Pennsylvania
City of Chapel Hill, North Carolina
City of Lancaster, Pennsylvania
City of Stockton, California
City of Dallas, Oregon
Security Water and Sanitary District, Colorado
East Canon Sanitation District, Colorado
City of Aurora, Colorado
City of Troutdale, Oregon
City of Portland - Tryon Creek, Oregon
Santee County Water District, California
City of Grand Rapids, Michigan
City of Boulder, Colorado
City of Colorado Springs, Colorado
Metropolitan Sewer District, Louisville - Hite Creek Plant, Kentucky
Johnson County Main Sewer Districts - Main Plant, Kansas
Johnson County Main Sewer Districts - Indian Creek Plant, Kansas
City of Glendale, Colorado

# APPENDIX G

## REFERENCES

1. CH2M/HILL, *Estimating Staffing for Municipal Wastewater Treatment Facilities*, A report prepared for the Environmental Protection Agency, March 1973.

2. Environmental Protection Agency, *Methods for Chemical Analysis of Water and Wastes, 1971*, National Environmental Research Center, Analytical Quality Control Laboratory, Cincinnati, Ohio, 1971.

3. URS Research Company, *Procedures for Evaluating Performance of Wastewater Treatment Plants*, for the Environmental Protection Agency, 1972.

4. American Public Health Association, *Standard Methods for the Examination of Water and Wastewater*, 13th Edition, New York, New York, 1971.

5. Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, *Recommended Standards for Sewage Works*, 1972 Edition.

6. Analytical Quality Control Laboratory, *Handbook for Analytical Quality Control in Water or Wastewater Laboratories*, for U.S. Environmental Protection Agency, National Environmental Research Center, Cincinnati, Ohio, June 1972.